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AGRICULTURE.

No. XLIX. SECOND SERIES. June, 1806.

Specification of the Patent granted to WILLIAM HENRY LASSALLE, *of the City of Bristol, Apothecary; for certain Improvements in Soap.*

Dated April 5, 1806.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said William Henry Lassalle do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, as followeth; that is to say: I take any quantity of such aluminous earth as can be had or obtained of considerable purity in the native state, or otherwise; I purify the same, if needful or desirable, by the mechanical or chemical means or practices well known and used in the arts. And I do grind, pulverize, levigate, or otherwise comminute, the said earth, and very carefully mix the same with strong alkaline ley or soap-lees, in sufficient quantity to render the whole imperfectly fluid. And I boil the said mixture,

with constant stirring, until the mass hath acquired a smooth uniform appearance. In the mean time I prepare in another boiler a quantity of soap, hot, fluid and nearly in the finished state, amounting to about three times the weight of the aluminous earth used in the former preparation. And in some cases I do separate the waste lees therefrom, and in other cases I do permit the same to remain, according to the intended quality of the composition I am about to make; and, lastly, I do pour the said hot mixture, or compound of earth and soap-lees, into the said quantity of hot, fluid and nearly finished soap, and unite the whole together, by constant stirring and boiling, until the same hath obtained a consistence proper for conveying the article into frames, there to be cooled for sale. And moreover, I do declare that the proportions of the said materials, and the manner of uniting the same together, do admit of certain variations, which are sufficiently evident to require no particular addition to the descriptions I have here given; and that I do vary the said proportions and mixtures according as it may be required to form a soap, which shall be more or less saline or more earthy, more soft or more hard, even so as to be reduced to powder, if needful, and the like.

In witness whereof, &c.

Specification

Specification of the Patent granted to JOHN DELAFONS, *of Threadneedle-street, in the City of London, Watch-maker; for his Invention of a Marine Alarum Chronometer, for ascertaining the Time of a Ship's Log Line running out; the Time of the Watches on Ship Board, and many other useful Purposes.*

Dated November 19, 1805.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Delafons do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, by the several drawings in the margin of these presents, and as follows; that is to say: I construct and make the said marine alarum chronometer for ascertaining the time of the ship's log-line running out, which is a substitute for the half and quarter minute glasses used at sea, which may be called or denominated a log-chronometer, as follows; and which, by various additions and alterations, as after-mentioned, may be made applicable to many useful purposes. In Figs. 1 and 2 in the said drawings (see Plate I.) the great wheel A has four pins or ratchet teeth fastened at a convenient distance from the centre; or (according to the use) a ratchet may be affixed with any number of teeth; B, the arbor which passes through the plates, and carries the hand or handle, having the end, or some part of this arbor or work affixed thereto, propelled forward by the main spring in the barrel C, or otherwise, as hereafter mentioned. This arbor has likewise the collet and piece D fastened to it, on which is put the spring and click E and F; this click having a tail or pin at the end G, which, passing by the pin or arch K, is drawn out of the ratchet. This click and discharge may be made in

different ways, as, diagonally, in Fig. 3, in which figure the piece K is flat and parralel to the great-wheel or tooth, a spring only, as shewn in Fig. 4, to act in the ratchet-teeth and discharge the arbor B (Figs. 1 and 2). The click being drawn out of the ratchet by the going of the piece, gives liberty to the arbor B to turn on the centres, and the hand or handle, or any piece affixed to the arbor, to strike against a bell, or any thing else, at pleasure. This hand or handle, or other piece affixed to the arbor, besides striking the bell, likewise strikes the end, or some inclined plane affixed to the pump piece I, as the nut L, or otherwise, which being struck by the hand or handle, or other piece as aforesaid, raises the pump piece I, and a pin affixed to it internally stops the machine by touching the escapement wheel or balance; when the bell is not used, this falling of the hand or handle, or other piece as aforesaid, is a sufficient notice of the expiration of the time required; the piece thus stopped will remain so when the hand or handle is turned to the quarter or half minute, or other time, until the nut is pressed down which discharges the pin out of the escape wheel, or otherwise, at the exact moment required; a spring bears against the pump-piece to keep it in its place when either up or down. The great wheel A, designed for nautical purposes, turns a pinion with a crown or balance-wheel, which acts in a common verge and balance with fans or flies to adjust it accurately to time, although any other escapement or pendulum-spring may be occasionally applied either to these for sea use or for other purposes. I also make the machines with a rack or portion of a wheel, as at Fig. 5, which, when it has acted on the pinion, will drop off by the power of the main-spring, and the rack itself, or any piece affixed thereto, or to the arbor thereof, will strike against a bell, or any thing else at pleasure.

Fig. 1.

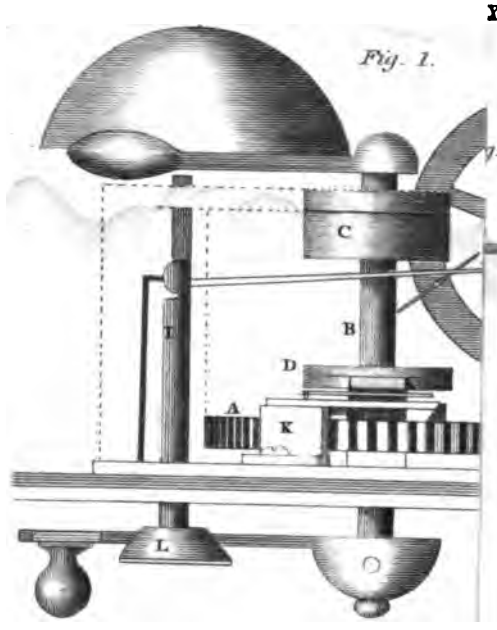
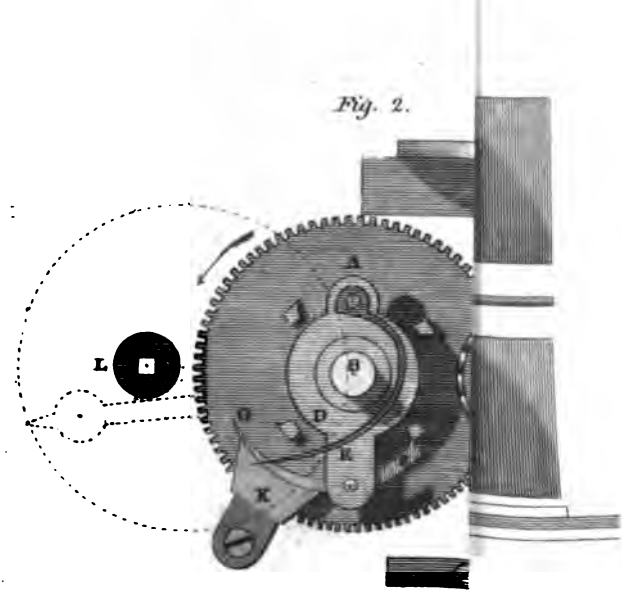


Fig. 2.



pleasure. There is a hand or handle upon the arbor of this rack to turn to the required time as before-mentioned; when this construction is used, there is a hole drilled through the pinion, and a ratchet or pin affixed on the wheel, and a click is affixed on this pinion, so that the pinion may turn one way, and lay hold of the wheel the other way, or the pinion and arbor may be fastened together, and the wheel be at liberty to move one way and hold the other; this rack may also, when it has done the work in one pinion for the going or time parts, drop into another for the purpose of ringing a bell, as is usual to alarums. When Fig. 5 is used, a collar or rim should be affixed on the blank of the rack of the same size as the bottom of the teeth, but affixed on the blank space between the teeth, which collar or rim falls into an arch, or pins affixed on the pinion, and thereby keeps the pinion in its place to receive the rack when wanted. The nautical machine may also be made with an escapement, and discharge as at Fig. 6; the letters corresponding with Figs. 1 and 2, render the first description sufficient; the mechanism may be placed in a frame like watch or clock-work, or supported by cocks on one plate, at discretion. The pinion M, Fig. 5, to give motion to a train, or otherwise to ring a bell, as is usual to alarums; or, if a portion of a wheel be affixed to the arbor B instead of the hammer, as at Figs. 1 and 2, and fall on a pinion as in Fig. 5, the effect will be the same. The great wheel A, in Figs. 1 and 2, or the rack in Fig. 5, may have the teeth contrate, which will bring the balance in another position, but in other respects produce the same effect. When these machines are wanted for other purposes, such as regulating the time of the watches kept at sea, or to awake any one at a given time, or for regulating the time for culinary uses, such as boiling eggs,

eggs, or otherwise, then the great wheel, A, Figs. 1 and 2, may turn any number of wheels, instead of the scape-wheel only, to multiply the time of the machine going; those I make for pocket alarums go twelve hours, those for culinary uses shorter spaces of time, according to the purpose to which they are intended to be applied. The numbers for the teeth of the wheels and pinions are calculated the same as watch-work. Where much accuracy is not required I substitute a train of wheels and a fly, or a skew-wheel and worm; I also omit the stop or pump work occasionally, and raise the hammer by a pin or tooth affixed to the ratchet or arbor of the great wheel, as the hammer of a clock is usually raised. These machines may be easily made by means of a weight instead of the main-spring with all the above properties, except they are not so properly portable, nor can they act in all positions. The power may also be given to the said machines by a spring similar to a gun-spring, either doubled or strait, or otherwise. The machines may be made of various metals, hard wood, ivory, bone, or similar substances, whichever may be thought most proper; but I prefer metal. In order to render the nautical machines impervious to the water, they are screwed in and variously affixed with oiled leather, bladder, or otherwise, and have a wooden or metal cap within a wooden or metal box, with a handle for convenient holding, but may be made in various forms to the same effect; they may also be made to pull by a chain or string, or to push in a manner similar to a repeating watch. The face of these machines should be divided according to the use they are intended to be applied to, and are set by turning the hand or handle to the time required to be known or determined.

In witness whereof, &c.

Specification

Specification of the Patent granted to JOHN BAPTIST DENIZE, *of West-street, Somers Town, in the County of Middlesex, Chemist; for a new Mode of procuring a greater Quantity of resinous, bituminous and oily Substances, from various Articles.*

Dated March 9, 1805.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Baptist Denize do hereby declare, that the nature of my said invention, and the manner in which the same is to be produced, is particularly described and ascertained according to the following principles, processes, and operations; that is to say: The theory or principle of my process for obtaining the greatest possible quantity of bituminous, resinous and oily matter consists in converting all the substances of the mineral, vegetable and animal kingdoms, of whatever denomination they may be, whether solid or fluid, the same being essentially composed more or less of carbon, hydrogen, sulphur and phosphorus, into those substances which are the object of my invention, by means of their being completely saturated by the most hydrogenous substances, taken indifferently from the said three kingdoms. Or, it may be said, by means of a new combination of their respective principles with a stronger proportion of those which constitute essentially the most inflammable substances of the three kingdoms, or are artificially extracted therefrom; and the following is a specification of the matters or substances I make use of as the bases of my operations, and by means of which the conversion or change in question is produced, *viz.*

Mineral Kingdom.—All natural productions described by naturalists under the generical head Bitumens, such as the

the different kinds of fossil, coal, peat, succinum, or amber, and all their respective species; Asphaltum, and its species; and all other substances analogous to the above, which are of an inflammable or combustible nature, as likewise the volatile product resulting from their combustion, and known under the generical head of Soots.

Vegetable Kingdom.—All the different species of gums, properly so called; mucilaginous bodies, either exsiccated or not; starchy and mealy substances; resinous gums; balms; concrete resins; the different kinds of wax, glue, or the resinous extracted substances of which it is made; coal resulting from the carbonisation of turf, soot, wood, and all kinds of vegetables, or the rubbish or refuse of vegetables, such as dunghills or compost; likewise the volatile product resulting from their combustion, known under the generical head of Soots.

Animal Kingdom.—Bones, horn, hair, skins and the strong sizes or glues made from these last; or with bones, the muscular, greasy, tripy and other oleaginous parts of all animals, particularly the larger kinds of them; the entire substance of sea and other fish, particularly the more oily sorts. All these things completely dissolved, and reduced into a kind of jelly, except the fat, from which I merely separate the skin which covers it; also blood, bile and such other fluid parts of large animals as are composed of principles like those of blood and bile; finally, all animal excretions or feculent substances, particularly those of the human body. Preferring of all the above bituminous, resinous and oily substances, and of those analogous thereto in the said three kingdoms, whether obtained directly or by distillation, or otherwise, those in particular in which the carbonic and hydrogenous, or else the sulphuric and phosphoric, principle

principle prevails most, and still more those in which the three latter are found in the greatest proportion.

The following is a specification of the matters or substances which I make use of for the converting of all those above enumerated in the said three kingdoms into those particular productions which I have made the subject of my discovery, *viz.*

Mineral Kingdom.—All kinds of soft fluid and volatile bitumens known by the several names of mineral pitch, petrol nephta, or productions of the same nature or analogous to them, whether soft, fluid or volatile, obtained by distillation or otherwise, from all or any of the concrete bitumens above described, and particularly those obtained by distillation or carbonisations of fossil coal, and by distillation of mineral pitch, and of the thick oil artificially extracted from fossil coal, such distillation being pursued until the matters or substances are reduced into a carbon or *caput mortuum*.

Vegetable Kingdom.—All kinds of fluid resins and essential oils, as likewise the different oily and resinous products, obtained by distillation or otherwise from all or any of the vegetable substances described in the preceding specifications; comprehending all kinds of tar extracted by incision or otherwise from all resinous kinds of wood; oils obtained either by expression or by distillation of those vegetable substances in which it is contained, and whether fixt, volatile or very thick, such for instance as those oils which are obtained by distillation or the different kinds of carbonisation, of turf and other sorts of vegetable rubbish or refuse, as dunghills, compost, &c. Finally and particularly, the volatile products resulting from the express distillation of all resinous or oily productions of which mention has been already made, pursued

until the matters or substances are reduced into a carbon or *caput mortuum*.

Animal Kingdom.—All kinds of greasy and oily matters naturally fluid, or rendered fluid or volatile by distillation, and generally products of the same nature, obtained by distillation of all animal substances, secretions, and excretions, described in the foregoing specifications, until the reduction thereof into a *caput mortuum*.

Preferring of all the said bituminous, resinous, and oily substances, and their respective analogies, in the three kingdoms, whether obtained directly or by distillation, or otherwise, those which are the most fluid and the most hydrogenous, or the most inflammable.

The Process or Manipulation.—In a very large copper, as deep as it is wide, made of such metal, or other substance, as that none of the principles or qualities of the ingredients can escape, and properly set in brick-work, and exactly closed with a moveable still-head of the same material, or equally impervious to steam, the latter being of a conical form, having the opening of the neck or mouth thereof of the same diameter as the opening or mouth of the copper; and a horn or conductor descending on each side of it, similar to the horns or conductors of a distiller's retort, whereof the opening at their commencement is as large as possible, so as to facilitate the passage of the steam, the apex or summit of the still-head being perforated, so as to admit an iron rod, stick or other handle, long enough to reach the bottom of the vessel, and to act within it like the milling or stirring-stick of a chocolate mill, without the steam escaping; I put, *first*, a certain portion or quantity of fossil coals, the least earthy, or the most charged with the inflammable principle, in preference to the other concrete bitumens which

which I have mentioned; or, instead of the latter, a like quantity of vegetable coal, derived from the different sorts of carbonisation which I have above taken notice of, the same being in either case previously entirely cleared of all extraneous substances, and reduced mechanically or chemically into a powder as impalpable as possible. *Secondly*, the like portion or quantity of the soots of fossil coal, or other concrete bitumens, in preference to those derived from the combustion of vegetable substances, these soots being well cleaned, or carefully cleared of all extraneous substances, and in like manner reduced to the state of an impalpable powder, by means of sieves or otherwise. *Thirdly*, two parts or a double quantity of blood, particularly bullock's blood, or instead thereof a like portion of human excrement, either of them in its natural state rather than in a state of exsiccation, and by no means mixed with any extraneous substances, and used in preference to the other animal substances which I have mentioned in their proper place.

To all these matters or substances, expressly specified or referred to as substances, in their respective proportions above mentioned, I add two-thirds or three-fourths, little more or less, of their total weight of soft or fluid bitumens, such as the mineral pitch, or one of their products thereto analogous, artificially extracted from the concrete bitumens; or, instead of either of these things, one or other of the products resulting from the distillation or carbonisation of fossil coal or turf, whether or not these products be changed by their partial exsiccation from boiling in water, or by the action of acids upon them, or by their more volatile principles being carried off by distillation or otherwise, provided such exsiccation has only tended to thicken them. And thus it is that I apply the dissolvents of my bases. But I make this mixture or medley

as follows: I mix the half of the said two-thirds or three-fourths of one or other of the said matters or ingredients used to dissolve my bases, with the articles reduced into impalpable powder, which I have above described under *first* and *second*, and which I take care to mix well together previously, by passing them together through the same sieve several times over. I amalgamate, calcine, and shake the whole together, in any convenient way, with a moderate fire under the copper, so as that there may result from this mixture, by means of requisite agitation and the action of the fire, a sort of nemogeneous paste, and so that the bases in question may appear strongly impregnated with the natural or artificial product made use of as the dissolvent. In the next place, I add to this first mixture the like proportion as expressed under *thirdly*, of either one or the other of the materials specified in that number, to which I now add the other half of the said two-thirds or three-fourths of the said natural or artificial dissolvent product used as aforesaid; and I repeat the same agitation, mixture and heat, so as to obtain the same result, namely, extreme attenuation of the bases, by their entire impregnation with the dissolvent product. In this instance also I continue the fire; always, however, taking care not to let any of the ingredients burn. I then examine the state of the whole mass, by taking a small portion of it, which I allow to get cold; and if, on breaking, it appears homogeneous, and nearly smooth in its grain or texture where broken, and spits or crackles but little when applied to the flame of a candle, I work the effect in question by putting on the still-head, upon the copper retort or alembic above described, so as not to lose the volatile, oily and other principles, which escape from the bases and their dissolvents in the course of their attenuation, and at the same time using the handle or stirring-

stirring-stick which I have mentioned; or I work the same effect without the still-head, but only for this once. As soon as the attenuation of the bases is brought to this point, I pour, through an opening made on purpose in the still-head, and with the aid of a funnel, the same dissolvent, to the amount of about a tenth part, little more or less, of the weight of the bases; but in as hot a state as possible. I then close the opening, work about the stirring-stick, and continue the attenuation, by increasing the fire insensibly, thereby the better to facilitate it. I examine occasionally into the state of the whole mass, by means of the opening in the still-head; and, as soon as it appears to me that it no longer spits or crackles when applied to flame, and that when cold the part where broken is still less ragged, and that it is become more and more smooth in its grain or texture, I still keep adding more of the dissolvent, so as to render its effects still more complete; and I do not cease doing so until I judge, by examining a portion of the mass, that it has acquired the degree of dissolution necessary for it to undergo in order to render it as fluid as the dissolvent itself.

To promote this end more readily and still more exactly, I add latterly to the mass, and each time in the same proportion of the said tenth part of the bases, the oily principle, which may have distilled in the course of the operations, and which I take care to collect in suitable receivers closely joined to the two spouts or conductors of the still-head, and well stopped at such joining; taking care also to put only so much of it as is requisite for obtaining the degree of dissolution or fluidity desired, and to separate with exactness the volatile dissolvent so distilled from all aqueous matter, either insipid or acid, which may have got mixed with it. I operate also in like manner

ner upon the same materials, by making use of natural or artificial products more fluid or volatile than those above employed; and which I have expresly set forth in the second part of these specifications, under the titular head Mineral Kingdom, so as by means thereof to volatilise my bases even to the degree of those substances, and particularly adding, as I have mentioned, the volatile oily matter which distils in the course of the operation; or else I obtain substances equally bituminous, thick, fluid or volatile, by operating in the same way individually upon each of the minerals described, as the bases of my operations, under the heads in which they are treated of, together with the different substances which I have also purposely described under the titular head Mineral Kingdom, in the second part of these specifications; or else, by also taking sulphur, which I convert in the same manner into fluid or volatile bitumen; and in order to obtain bituminous concrete matter, and certain kinds of mineral pitch, I distil separately each of the thicker substances produced by the several manipulations which I have just been treating of with an adequate fire, and continued for a sufficient time to detach the volatile aqueous acid, saline and oily principles which they contain, and this in such a sufficient proportion or quantity, as that, on inspecting the mass, it may be found reduced by that exact subtraction to the state of solidity or hardness I wish, according to the object I have in view in the operation; and, particularly, I distil in the same manner and with the same precautions, specially to obtain bitumens or bituminous, concrete and very solid substances, 1st, Mineral Pitch; 2dly, the thick black bituminous and empyreumatic oil which is artificially procured from fossil coals, whether by distilling or carbonising them, in any possible way; 3dly, the sort of pitch in any way made with the

said

said bituminous oil; 4thly, the oil equally thick, but fœtid and high coloured, which is also procured from turf, compost and all other kinds of vegetable rubbish by their several distillations or carbonisations. I obtain resinous, extracto-resinous, and resins-extractive, or bitumino-resinous matters or substances, equally thick, fluid, volatile, and of the consistence of pitch, or even still more concrete, by merely following the general plan of operations which I have just set forth for the obtaining the different bituminous substances which I make, and working upon the same bases in the same proportions, but using in this case, as the dissolvent of my bases, one or other of the resinous or oily substances which I have purposely set forth in the titular head Vegetable Kingdom, in the second specification, particularly the different kinds of tar and turpentine, and the products resulting from their distillation, as also the different sorts of vegetable pitch, but always preferring for these bases and their dissolvents the resinous and oily substances in which hydrogen is found in the greatest proportion. I obtain matter, more particularly oily, by conforming to the directions I have just given for the obtaining of the resinous matter, but using in this case, as a dissolvent of my bases, one or other of the oily substances I have purposely set forth under the titular head Animal Kingdom in the second specification; in like manner, preferring for the bases and their dissolvents those of the substances which I specified under that head as being the most volatile and the most hydrogenous. In fine I prefer all the foregoing products, whether bituminous, resinous or oily, according to the object I have in view by oxygenating them, more or less, by all the known means. It only remains to mention that the form of the vessel which I have described above, is not essential to the above-mentioned operations; and

and that I therefore make use of any other kind of vessel or utensil, the form whereof enables me to obtain the same results; and consequently do not conceive it necessary to delineate the plan or model of it in these presents. But in whatever form the stilling-vessel may be constructed, I fill it only two-thirds full on account of the violent ebullition of the ingredients towards the end of my operations, particularly when I use the blood or other animal substances reduced to jelly; and further, to avoid this inconvenience, I make the additions of the dissolvents only, after having entirely separated the water and the acids from the preceding additions, and taking care previously to each addition to diminish the heat of the mass, which at other times I keep almost always in a boiling state, and especially when the bases which I am using are of an infusible nature. Moreover, to prevent the coagulation of the blood, and the said jellies or gelatinous substance in any preliminary operation, I take care that it is a very slow fire by which I dissolve them, unless I use the said ingredients entirely exsiccated and reduced to an impalpable powder, like as I reduce all my other bases except those of a fusible nature. Finally, I have to remark, that in the same way as I operate on each basis in particular, or upon some or all of them united, in equal or unequal proportions, so I use as my dissolvent of the bases so employed one or more, or all together united, of the dissolvents herein before mentioned, the which I use in like manner in equal or unequal proportions, so as to form by this latter mode of operating products of a nature analogous to the bases and dissolvents respectively employed to obtain them.

In witness whereof, &c.

Specification

Specification of the Patent granted to THOMAS KENTISH, *of Baker-street, North; in the Parish of Saint Mary-le-Bone, in the County of Middlesex, Esquire; for certain Improvements in the Construction of Machines or Engines applicable to the moving, raising, or lowering heavy Bodies and Weights of all Kinds, either upon Land or on-board of Ships and Vessels, and to various other useful Purposes.* Dated February 20, 1806.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Thomas Kentish do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, by the drawings delineated in the margin of these presents, and as follows; that is to say:

Fig. 1, (Plate II.) represents part of a ship, and the manner in which the machinery is affixed to a derrick or crane. A, the derrick, which may be fixed to a ship's main-yard, main-mast, fore-mast, or any other convenient place, or to a strong post in the ground upon land, or to the side of a building, &c. B, the purchase wheel, from two feet diameter to six or ten, as the purchase may require; the groove to admit the rope to pass round, to be three or three and a half inches deep; the thickness of the wheel and frame to be from four to eight inches, according to the quantity of rope required to be wound round it. The purchase wheel may be fixed to any part of a derrick or crane as may be found best adapted, or convenient for its use. C, the axletree of the wheel B, iron covered with wood, to be formed in inclined planes from three feet long to six feet, or more; the diameter in the centre from six to twelve inches, according to the

power desired. D D, four iron bars to support the purchase wheel, from half an inch to one inch thick. E E, two iron bolts, through the centre of the derricks, to fix on the bars D D with iron or brass nuts and screws. F, a roller, formed of wood, with an iron axletree, to take the rope off the purchase wheel B, six or eight inches diameter at each end, and about four inches or more in the centre, with two inclined planes; the one on the right about two inches long and fluted, to hoist the weight up, the other side from centre to the left one inch long plain, the two inclined planes at forty-five degrees angle of slope, to lower the weight down. G G, four iron plates or bars to support and fix the roller F, with iron bolts, nuts and screws, with flat heads. H H, the handles, fastened to the ends of the iron axletree of the roller F by spring keys, chained to the handles, to turn the roller in hoisting, and to be taken off when lowering. I, the rope which passes round the purchase wheel B, and through the centre of the derrick, and is taken off by the roller F; to be two inches round, or more if required. K, a shiver, fixed in a groove cut through the centre of any part of the derrick, as may be found most convenient for the rope I to pass through. L L, the rope to wind round the axletree C on each side of the purchase wheel B, from four and a half inches to five inches round. M, two blocks, to be hooked or fixed to the head of the derrick or crane, for the rope L to lead through. N, a shiver, to extend and keep the rope L, and to prevent it from taking a turn; it may be a straight stick or block. O, a large hook, fastened to N with a strong iron strap, to hook slings upon, or any other articles. P, the stop for the derrick or crane. Q, the guy, to support the head of the derrick or crane, which may be hoisted or lowered, as occasion may require. R, the

thwart

Fig. 3.

Fig. 2.

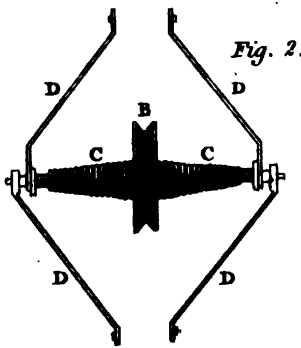


Fig. 1.

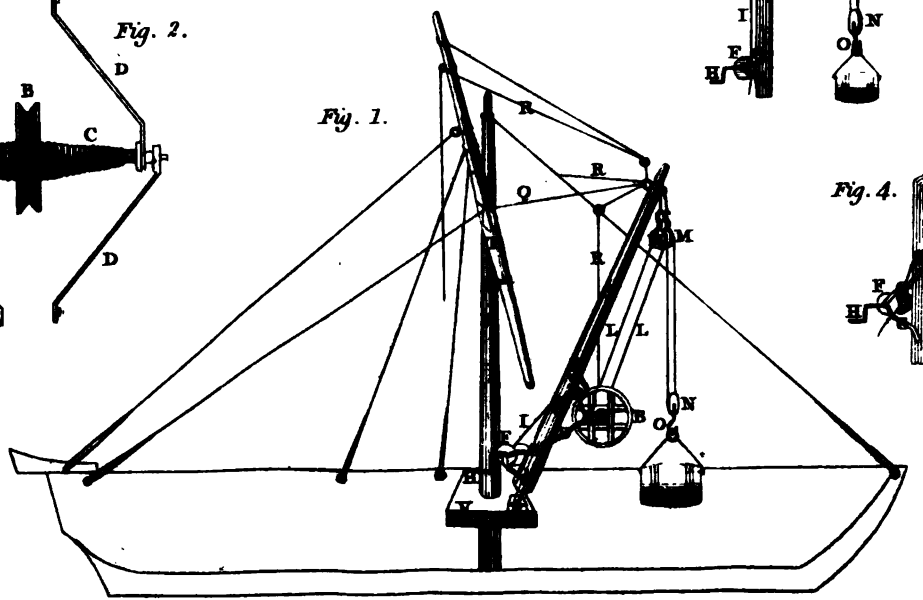


Fig. 5.

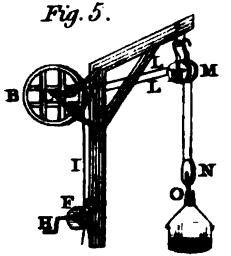
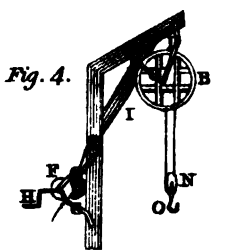


Fig. 4.



thwart guys. S, a ship's main-mast. T, the main-yard, either square or to be topped up, to fix the guys to. V, the deck of the ship.

Fig. 2, shews the form and construction of the purchase wheel B, in a front view, with the iron plates for supporting the same.

Fig. 3, shews the roller F, with its inclined planes, and fluted in part of its centre, with the handles fixed on.

Figs. 4 and 5, represent two cranes, with the purchase wheel B and roller F, with other parts of the machinery, delineated in Fig. 1, with the same references, in order to shew how they are applied to cranes and other engines of the like nature made use of upon wharfs, warehouses, and other places; and also, that the dimensions and strength of which must depend on the weight required to be raised. The positions of the different parts of the machinery may be altered, transposed, and adopted in different ways, as may be found most eligible to the situation in which they are to be fixed, and to various purposes where the moving heavy bodies, and hoisting and lowering weights of all kinds, is required, either upon land or on-board of ships and vessels.

In witness whereof, &c.

Observations elucidatory of the Specification of Mr. STANSBURY'S *Patent for Locks and Keys upon an improved Construction. By the Patentee.*

Communicated by him in a Letter to the Editors.

GENTLEMEN,

AS the pages of your interesting work are open to remarks from the patentees of inventions, and particularly as such remarks will generally tend to elucidate the spe-

cification, by conveying the author's apprehension of his own contrivance, unembarassed by a scrupulous attention to the letter, and pointing out, not barely the peculiarities of construction which distinguish it from others, but also illustrating its uses; I take the liberty of sending you a few observations on my lock and door catch, the specification of which was given in your No. XLVI. for March last. This invention, I am happy to state, has already met with the approbation of many distinguished judges who have examined it, and has been found on trial equal to my most sanguine expectations. The principal inducements to bring forward a new lock at a time when the public were already supplied with several possessing eminent claims to ingenuity, were, the superior simplicity and durability of my plan, uniting at the same time at least an equal degree of security with any in the market, and admitting of an infinite variety in the keys. The first is an object of material consequence: when we recollect how common is the complaint of locks "getting out of order," it is surely worth while to study such a construction as shall, by its simplicity, be secure from derangement. In my lock, instead of the introduction of tumblers, wards, sliders, &c. usually employed as securities against picking, and which are liable to injury, nothing is to be seen but a plain surface of case-hardened iron. The springs or pins which hold the plate are completely defended by it, and their points are all made level with its surface, so that nothing but the real key will touch them, and release the bolt. I have stated in the specification the infinite changes these points admit of, and which is a security against having two keys alike, an evil of the greatest magnitude; for of what use is the most secure construction, if another person possesses a key to your lock?

I should

I should not omit to mention a farther advantage attending my invention, that of having locks in suit, with each different from the rest, and yet all opened by one master-key. This may be carried to any required extent, without any extra trouble or expense, and is effected by merely changing the order of the points.

With regard to the new modes of releasing the spring-bolt stated in the specification, I have preferred that which was the most simple; it consists of a wedge, projecting transversely from the spindle commonly used, which being pressed releases the catch. This wedge, to prevent friction, acts upon a roller attached to the end of the spring-bolt. The followers used in common locks are still retained, so that a person may either turn the handle as usual, or adopt the more simple and ready mode of a direct pressure to open the door; the latter is preferable on many accounts, but principally because it is not liable to get out of order by being overturned. To answer the purpose of the short bolt used as an inside fastening, I make a piece to turn into a notch in the common catch or spring bolt, by which means it is held, and cannot be released from without; this may be done either by a separate knob, or by making the escutcheon turn a button within the lock; but I find the knob is preferred, and have accordingly adopted it.

These locks will shortly be for sale at Mr. Roberts's, Oxford Road, and Mr. Hewlett's, Strand, as well as a few other respectable ironmongers.

Yours, &c.

London, May 10, 1806. A. O. STANSBURY.

Observations

Observations on the Patent lately obtained by Mr. JONES, *of Birmingham, for Improvements in the Mode of manufacturing Barrels for Fire-Arms, by Messrs.* THOMAS *and* JOHN GILL, *of Saint James's-street.*

Communicated by them, in a Letter to the Editors.

GENTLEMEN,

SEEING in your last month's Repertory of Arts, &c. the specification of a patent lately taken out by Mr. John Jones, of Birmingham, for a method of making gun barrels, we are compelled to state, that our late father invented machinery for making twisted gun barrels exactly similar to that specified, but applied in a much superior manner, upwards of ten years ago; and that we have here a gun barrel twisted by it in the unwelded state, and other specimens, ready to shew to any persons who may be interested in the subject; which will completely substantiate his claim to the said invention.

Yours, &c.

London, May 23, 1806. THOMAS and JOHN GILL.

On the Management of Marsh Lands, Irrigation, &c.

By Mr. DAVIS, *Steward to the Marquis of Bath.*

From LETTERS and PAPERS of the BATH and WEST of ENGLAND SOCIETY.

WITH respect to the management of marsh lands *after draining*, the great desideratum is to make them perfectly dry—to get rid of the coarse aquatic grasses, and to replace them with the finest and best grasses; and as the latter root is much shallower than the former, they

they cannot be made to thrive, unless the land is firm and close round their roots. There are but few instances where land of this description does not contain plenty of the best grasses, but in such a weak and starved state that you can scarcely see them until the land is drained, and made so firm in its surface as to discourage all the coarser, and encourage the finer grasses by bringing vegetation near the surface, and affording a proper nidus for the small shallow root of the latter.

But between the decay of the coarser grasses and the establishment of a better kind there will be an *interregnum*, in which the land will be worked very little; in *some instances less than before it was drained at all.* The inclosures and drainage of the marsh lands (called moors) in Somersetshire, and the fens in Lincolnshire, have shewn this very clearly, and the same cause must produce the same effect every where.

For the first three or four years after the drainage, the land has generally grown gradually worse; for two more it has been stationary; and then, if well managed, and particularly by the help of a dry summer, it has improved rapidly; and will never, unless shamefully neglected, revert to the former state.

But this *interregnum* may be much shortened, by reflecting on its cause, and acting accordingly. If the coarse grasses are to be destroyed, they must not be suffered to seed. If the shallow-rooting fine grasses are to be encouraged, the earth must be trodden into contact with their roots; of course mowing should be avoided, and feeding *in dry weather, as hard as possible, encouraged;* and the stock should be that of the *cow kind.* Horses eat very unfair, and are continually running about and poaching the ground; and sheep will pick out all the fine grasses, and leave the coarse. But the surface water must

must mostly be drained off; and feeding in wet weather, particularly in the winter, avoided as much as possible.

I am supposing all this while that the land has been completely drained of its *under-water*, or else it is useless to attempt any thing towards its improvement. Manure may as well be thrown into the water as put upon land, which (though not always under water) *is full of water* every winter. Besides, the *under-water* of marsh land, particularly under the hills which contain veins of blue lyas stone, as in Lincolnshire and Somersetshire, is frequently so impregnated with sulphur as to be very injurious to vegetation; and the land never improves much, till that water is completely drained and kept out of it.

When land of this description is recovered, and well stocked with good grasses as above described; those grasses should be encouraged by such manures as suit the soil, such as wood-ashes, peat-ashes, soot, and other top-dressings in the spring, till the grasses are completely established; and then lime, chalk, marl, clay, sand, or whatever suits the land best, may be used in large quantities as *alterative manures*, but not until there is *a good coat of grass on the land*. In the choice of these manures, local manures will be useful; theory, on the soundest principles, is sometimes fallacious. But the golden rule of agriculture—to use such manures as will make heavy land lighter, and light land heavier; cold land hotter, and hot land colder, must never be lost sight of. He that knows and follows this rule, and he only, is a farmer.

If any of your land be capable of irrigation, and you have *water enough* to do it properly (the great error has been in attempting too much land with a given quantity of water) no improvement can be so great. But the land must not only be first drained of its under-water, but must

must be by nature, or made by art, capable of draining itself, and that speedily, from the water to be brought on by irrigation, or the attempt should not be made; and marsh land is seldom in that shape, unless *a river runs through it*, and there is of course a natural fall in the land: where you have that advantage embrace it by all means; if you have not, be shy of attempting any thing on a large scale, until you have consulted some one who perfectly understands the subject. With all the improvements to be derived from irrigation (and it certainly is the greatest improvement in agriculture), local prejudices in countries where it is but little known, are strong against it. Every thing may look favourably, and yet the water may not agree with the land or the land with the water; and the owner may be put to a great expense, and not only be disappointed, but what is to the full as vexatious, be laughed at by all his neighbours. Begin therefore with a little, and do that little well. You must not pretend to undertake irrigation by any written instructions which I or any one else can give you. You must get a man who understands the subject practically, and who will undertake it at a fixed price per acre. But even then I would do but little at first, then wait a year, and see the effects before I would go farther. And, by the bye, it is absolutely necessary that your own workmen should see the effects, and understand the subject, and be fond of it; for every farmer, let him profess what he will, is governed by his own workmen; and whatever he may attempt to do will never fully succeed, unless he can get them to like it as well as himself.

On the Nature and Properties of Manures, and the Mode of preparing and applying them to various Soils. By ARTHUR YOUNG, *Esq. F. R. S.*

From LETTERS and PAPERS of the BATH and WEST of ENGLAND SOCIETY.

The first Bedfordean Medal was voted by the Society to Mr. YOUNG *for this Essay.*

PART I.

Of the Manures made or dug on the Farm.

CHAPTER I.

Of Marle.

MARLES the most common in England are clay marle, stone marle, and shell marle. They are by some distinguished by their colours, white, red, blue, black, &c. but colours deserve no other attention in these bodies than as indicative of iron.

§ 1.—*The Nature of Marle.*

The Bath and West of England Society is a body much too enlightened to use any term in an advertisement, the purport of which has not been well considered. When, therefore, the expression *nature* is admitted, as distinct from *properties*, they seem to require some intelligence on the component parts of the substances used as manures; alluding probably, by the term here adopted, to the *passive* qualities of bodies, as the *active* ones are supposed to be discriminated under the word properties.

Marle is a fossil substance, usually composed of sand, clay, and calcareous earth; the red and black marles have a small quantity of iron. I have analized red marle from Cheshire, which had seventeen grains in one thousand;

sand; and there are very few specimens, even of the whitest marle, in which prussiat of pot-ash will not give some note of the presence of that mineral. The quantity of calcareous earth varies extremely, from 25 to 80 *per cent.* Mr. Kirwan remarks the impropriety of not calling a body chalk which contains more than 80. One of the best clay marles contained 40 *per cent.* of calcareous earth, 50 of clay, and 8 to 10 of sand, with clear signs of some iron.

Marle falls in pure water;—but all examination by water is uncertain, if the water itself be not first analized. It falls also by exposition to the atmosphere. Of its three constituent parts, calcareous earth is composed of about one-third * part carbonic acid, which is driven off by heat. The clay contains generally a small portion of iron, a little volatile alkali †, and some sulphuric acid; and even when deprived of all organic matter, yields hydrogen gas. The sand, if *clean*, contains none of these substances. Phosphorus may be gained from all calcareous earths.

§ 2.—*The Properties of Marle.*

The property that renders this manure particularly valuable, is the calcareous earth (carbonate of lime) it contains; and to every enlightened farmer it must be sufficiently evident, that as all fossil manures are intended to correct or improve the texture of the soil, its constituent parts must be known, before any application can rationally be made of this or any similar manure.

* By Mr. Kirwan, a third; by Bishop Watson, 9 in 20; and by other authors, with some small variations. Extreme accuracy is desirable in merely philosophical experiments, but useless in agriculture.

† Boyle, Kirwan, &c.

A fair specimen of each division of soil should be selected; I do not say field, because the line of fences may not be the line of change in quality. In this selection every material circumstance of elevation, slope, shelter, &c. should be had in contemplation, and the usual quantity of rain that falls in the district. The specimen should be taken from very many spots, that the average may be the fairer. The authors are numerous who direct how soils are to be analized. The grand object with relation to marling, is to discover the proportion of calcareous earth already in the land; and it is easy, while this is doing, to find the proportions of sand and clay; which three constituents form the texture of a soil.

It is extremely difficult to discover, from the knowledge at present possessed by the public, what ought to be the quantity of calcareous earth in a soil. The best specimen analized by Giobert, had 6 *per cent.*; by Bergman, 30 *per cent.*; by Dr. Fordyce, 2 *per cent.*; a rich soil, quoted by Mr. Davy, in his lecture at the Royal Institution, 11 *per cent.* This is an enquiry concerning which I have made many experiments, and on soils of the most extraordinary fertility. In one, the proportion was equal to 9 *per cent.*; in another, 20 *per cent.*; another, 3 *per cent.*; and in a specimen of famous land, which I procured from Flanders, 17 *per cent.* But the circumstance which much perplexes the enquiry is, that many poor soils possess the same, or nearly the same, proportions, as these most fertile ones. To attain the truth in so important a point, induced me to repeat many trials, and to compare every circumstance; and I am disposed to conclude, that the necessity of there being a large proportion of calcareous earth in a soil depends on the deficiency of organic matter; of that organic matter which is convertible into hydrogen gas. If the farmer find, by experiment, that his

his soil has but a small quantity of organic matter, or knows by his practice that it is poor, and not worth more than 10*s*. 15*s*. or 20*s*. an acre, he may then conclude that there ought to be 20 *per cent*. of calcareous earth in it; but if, on the contrary, it abound with organic matter, and be worth in practice a much larger rent, in that case his marle cart will not be called for, though there be but 5 *per cent*. or even less, of calcareous matter. Another motive for marling, which also concerns the texture of the soil, is that of giving tenacity and firmness; for this purpose clay marles are better than any other. One property of the calcareous earth which is in marle, is that of correcting acidity. Some soils abound with acid particles, which are prejudicial; these are neutralized, and rendered, if not beneficial, at least harmless.

That it is a property of the calcareous earth to be taken up by plants, there is great reason to believe from many experiments. The earth of vegetables is for the greatest part calcareous *. Water dissolves $\frac{1}{660}$ part of its weight of calcareous earth; and we find in this $\frac{1}{100}$ of carbonic acid, and thus impregnated, it dissolves $\frac{1}{1500}$ of its weight of carbonate of lime †. The vegetable acids have a great affinity with calcareous earth ‡. In this respect, however, the quantity demanded is very small; for Lord Dundonald asserts, that all the calcareous earth to be obtained from an acre of most crops will not exceed 80 pounds. Should the soil be deficient in calcareous earth, the application of marle must with this view be important.

In regard to sand and clay, they both enter as component parts of vegetables; but they abound in all soils sufficiently for this purpose. A material advantage

* Kirwan. † Burgman. ‡ Senebier.

attending

attending the use of calcareous manures results from their assisting the putrefaction of animal and vegetable bodies *. The particles, waste, and remnants of vegetables unconsumed, which all lands abound with, are thus assisted in the decomposition, and prepared for becoming the food of fresh vegetables. Dung also, when applied after such a manuring, acts sooner, and with greater effect. Of composts I shall speak hereafter.

§ 3.—*Collecting.*

The common way of procuring marle is by digging. It should however be mentioned, that it is dredged up from the beds of some rivers, particularly the Shannon.

The white shell marle, and a white species of singularly specific levity (probably the *agaricus mineralis)*, are both found under bogs, and also at the bottom of lakes.

No person, whose land wants marle where it is not generally known to exist, should be satisfied without a most careful examination by boreing. A borer for twenty feet depth does not cost above 3*l.* (for eighty feet not more than 20 guineas) and it is used without difficulty by any common workman, after a little attention in explaining it. The bottoms of lakes and rivers should be also examined.

§ 4.—*Preparation of Marle.*

None.

§ 5.—*State in which applied.*

Whatever benefit may result from exposition to the atmosphere, it must be attained after spreading; the quantity is too large, and carriage too expensive, to permit any additional operations. If dredged from the

* Macbride, Pringle, Lavoisier, &c.

bottom

bottom of lakes or rivers, the heaps should be left from six to twelve months.'

§ 6.—*The Application.*

Under this head must be considered,

1. Carting.
2. For what Crop.
3. Depth of tillage.

The expense of carriage is every where so great for bulky manures, that every means should be used for lessening it. The most important improvement in this respect is that of substituting one-horse carts instead of the larger ones in more common use. The superiority in every respect of expense, *viz.* of vehicle, number of horses, weight drawn, drivers (proportioned to weight, &c.) has been so well ascertained, that the point should be considered as proved and done with.

The crop for or on which marle is first carried must be either on lays or layers, as they are called, or fallow. The former is much the best, as the farmer has the power of leaving it exposed six, twelve, or eighteen months; the longer the more advantageous *. The successive changes of the atmosphere moulder it down; and the roots of the grass combine it with the surface, where it is preserved much longer than if stirred immediately by the tillage of a fallow. This remark applies proportionally to the looseness of the soil on which it is spread. On sandy soils it is essential to good management. But I have in my own practice found, by the use of some thousands of loads, that the above position is strongly applicable to wet and heavy loams, as well as to sandy

* See two very valuable practical papers on this subject, by Mr. Macro (Annals of Agriculture); and by Mr. Rodwell (Communication to the Board of Agriculture).

loams,

loams, both of which have been greatly improved by clay marle. Let it be remembered, that all fossil manures have a constant tendency to *sink*, so that in a course of years they will subside below the action of the plough; and this takes place pretty much in proportion to the number of ploughings which the land has received.

Thirdly, respecting the depth of tillage. The most experienced farmers are apprehensive of turning marle in too deep. The most approved practice is to plough the layer shallow for peas. There is but one objection to turnips, and that is, giving so much tillage so early after the improvement. Avoid potatoes, for I have found them mischievous in this period of marled land.

§ 7.—*The Season.*

This is soon dispatched; for the business of marling is usually done on such a scale as to preclude choice; it must be performed when the teams have leisure for the work. And if these are bought for the purpose, in order to finish a whole farm as fast as possible, that the farmer may reap the longer benefit, they are generally kept at work the whole year through; but if the business is on a smaller scale, so that the farmer may have his choice, on all wet and heavy soils it should be summer work, and on dry ones it may be as well performed in the winter.

§ 8.—*The Quantity.*

This is an object of extreme importance; for I have known very ill effects from giving over doses of marle, and in some cases the fact is curious. In the earlier stages of the improvement in Norfolk, and even to the present time, some farmers, from experiencing the evil of looseness, and a want of texture in their poor sands, marled at the rate of from one hundred and twenty to one

one hundred and fifty cubical yards *per* acre; and the consequence was what they term *setting*. The firmness was produced, but being too much at the expense of friability, a necessary property in sand, the productiveness of the fields was *damaged* for twenty years; so that at present upon sands of weak fertility, from sixty to eighty yards, or forty to sixty large loads, are a common quantity, and found to answer well. If rather underdone, they find it better to give a *second* dose than more at once. This prejudice from overmarling is remarkable; because, after it is done, the analysis of the surface will indicate no improper proportions, nor any which are not found on very rich soils. I conceive it is for want of the additament being homogenous, and well assimilated with the sand, as in soils of a natural texture it is rather a mixture than an incorporation. But *why* this should continue for so many years, it is very difficult to account for. When the evil is discovered, the management should be varied. Seeds should not occur so often, nor be left so long as usual, and tillage more freely exerted; this will accelerate the subsidence, and the marle will be more beneficial in such a case below than on the surface. The quantity to be spread on poor, loose, wet loams is much more considerable than on loose sands; I have not known, in this case, too great a dose given; though I have spread as far as one hundred cubical yards *per* acre, and have known much more. The marle in this case assimilates more easily. On loose peat bogs, and on moors, the greater the quantity the greater the improvement. In all cases where the object is to give calcareous earth, the quantity necessary is much less than when the intention is to consolidate the texture of the soil. In East-Norfolk, where the texture approaches to perfection, they lay on so little as ten or twelve to twenty

tons. In Somersetshire, thirty loads an acre, raised by a shaft, has improved from 2*s.* 6*d.* to 31*s.* 6*d.* an acre.

§ 9.—*The Soil.*

The defect of a soil must be understood, before a wise farmer will put himself to the expense of marling. The experience of every day will inform him if his land want tenacity and consolidation; but the want of an addition of calcareous earth, as a food of plants, can be discovered only by analysis. There are other circumstances which demand attention. If the *chrysanthemum segetum*, the *polygonum pensylvanicum*, and the *rumex acetocella* abound, the experienced farmer will pronounce that the land wants marling; and turnips producing deformed strings of roots, without swelling into the proper globular form, or being extremely subject to the well-known distemper of the *anbury*, both afford a similar proof of too much looseness of texture, and suggest the consolidation of clay marle. Those evils vanish after this operation. The *erica vulgaris*, or common heath or ling, abounding in land, is generally a proof of an acid soil; and all peat soils are found, on analysis, to contain a considerable quantity * of the gallic acid, or tanning principle †. Some have been rendered quite steril by acids ‡. "I was led," says Mr. Wight, "to see a stratum of moss impregnated with vitriolic acid so abundantly, that out of 4lbs. of the moss one pound of green vitriol was extracted §." There is a bog in Bedfordshire, in which sulphat of iron abounds in a degree almost equally extraordinary; but it has been converted into one of the finest watered meadows in England, by his Grace the Duke of Bedford. Wherever such soils are found, the applica-

* Essays Physical and Literary, vol. ii. p. 249. † Hendrick.

‡ Darluc Hist. Nat. de Prov. vol. ii. p. 127.

§ Husbandry in Scotland, vol. iv. p. 415.

tion

tion of marle, by reason of its calcareous earth, is sure to have great effect. Instances are too numerous to quote; the acid is converted into sulphat of lime, or gypsum, and consequently harmless, if not beneficial. Upon wet but loose loams, which are found when manured to be more productive of straw than corn, I have found clay marle to be a cure, and attended with unquestionable profit. Another quality of these loams is that of being uncommonly pestered with the red worm; and it is a singular quality of marle to lessen this evil considerably: whatever gives them a firmer texture has a tendency to this effect.

CHAPTER II.

Of Chalk.

The difference between marle and chalk is not so great as to demand a repetition of sections. It will be sufficient to point out the circumstances in which there is a variation. Chalk is a substance in which there is a greater proportion of calcareous earth than in marle, and at the same time it is comparatively harder; for though many sorts of chalk will, when exposed to the atmosphere, moulder down into powder, yet others require some years to effect such a reduction; and though we do meet with soft chalks, they are not common. Many specimens of this fossil have been analized that yield above 90 *per cent.* of calcareous earth; and Mr. Marshall registers one that contained 98 *per cent.* The properties are nearly similar to those of marle. The circumstances in which they vary most are, the calcination of this body for making lime, and the power it has of rendering tenacious clay more dry and friable; whereas stone marle alone has not the same effect, and is inferior to the hardest sorts of chalk. It is also more common to chalk grass lands than to marle them; and it works a capital improvement

on low, coarse, sour meadows, rendering them firmer, and improving the sweetness of the herbage.

In raising chalk there is one distinction from marle (unless of great solidity), which is that of sinking shafts for it. This is the general practice of Hertfordshire. The chalk drawers travel in gangs, chamber it all round, leaving columns to support the incumbent earth, and draw it up in buckets. They will wheel it on to the land for 8*d.* the load of twenty-four bushels, to the distance of twenty poles from the shaft. This is a much more convenient and a cheaper way than opening marle pits; and it saves, on strong land, the mischief of poaching by the draft of horses.

Relative to preparation, state, application, and season, the remarks on marle may be referred to.

In regard to quantity, it is generally used in much smaller quantities *per* acre than marle. In Essex, where it is brought by sea from the Kentish coast, from five to eight waggon-loads are attended with more remarkable effect than even dung itself, if the land has not been chalked before. More than forty cubical yards an acre are rarely spread.

In the soils upon which chalk is used there is a considerable variation from the practice relative to marle. The most remarkable effects which I have seen attending it have been upon good sound loams, worth from 15*s.* to 20*s.* an acre. Six or seven waggon-loads *per* acre are seen immediately in the crops, and to an inch. Six miles from Maldon in Essex, where it is spread at the expense of about 20*s.* *per* waggon-load, the same result has been observed; and also at Enfield; the soils have not been analized, but it may be supposed that they are, though valuable, deficient in calcareous earth. It is remarked, that chalk presently gives the land a reddish colour, so that the part of a fallow which has been chalked will, from that tinge, be discernible at a distance. A

very

very singular circumstance observed in Essex is, its being an enemy to what their farmers call grazing, or running to turf. A field, which before chalking will run of itself to a fine head of white clover, does so no longer after chalking. The chalk is not soft, but rather hard. The sharpest frosts leave many lumps unbroken, which must be done with pickaxes; and the hard bits, which break to a clear white, are better than those which crumble between the fingers. This attaches to the texture of the soil, which is rather too stiff for turnips.

Soils abounding with spontaneous wild sorrel are well known to be highly improveable by chalk; and Lord Dundonald has a remark which applies to the fact: "The oxalic acid, or acid of sorrel, is found in the plant of the same name, combined with the vegetable alkali. Much of the oxalat of lime will be formed by adding calcareous matter to the ground abounding with plants of sorrel, or other vegetables containing the sorreline acid. From the insolubility of oxalat of lime, it is not probable that it can contribute, *per se*, to the food of plants. It cannot be decomposed by alkalies on superior affinity, but it may by the vitriolic acid, in which case gypsum will be formed; and the acid thus disengaged will combine with fixed or volatile alkaline salts, or magnesia; these are soluble, and promote vegetation in a high degree."

Chalk is used successfully on all soils upon which marle is found to answer. It is not a general favourite in Norfolk for poor sand, or even middling ones; but some farmers, of considerable note for accuracy of observation, have of late used very hard chalk, and with great success.

On all moors, peat bogs, and peat fens, every species of calcareous earth is applied with singular effect: chalk is to the full as valuable, or more so, than marle, as it contains more calcareous earth.

TO BE CONTINUED IN OUR NEXT.

On

On Tinning. By Professor Proust.

From the Journal de Physique.

THE following experiments are a supplement to the work published on this subject in 1803, (inserted in our sixth volume, second series). They decidedly confirm the harmless nature of lead, when alloyed with tin, even beyond equal parts. There can be no doubt, but when the prejudices which still exist against this fact shall be entirely dispelled, that pewter, such as was used by our ancestors, and the ordinary tinning will again be resumed, even if it be true that they have ever been entirely out of use. I will even venture to assert, that they will be used with much more confidence, since every one now will be perfectly convinced of their salubrity.

Lead is undoubtedly a dangerous metal, but it is conditionally so, like copper, mercury, silver, &c.: that is, when oxydation has reduced it to that state in which the metals above mentioned become strong poisons. I would ask those who pretend to dread a grain of tinning, has it never occurred to them that this metal, which seems to be feared much more than lead, or even copper itself, when reduced to a powder, will remain in the stomach and intestines without leaving the least trace of those mischiefs which the above metals would cause in their oxyd state, being then dreadful poisons? What would they oppose to the experiments of Dr. Dronard? We have seen children swallow small copper coins without appearing to be the least affected by them. But copper in dust, and even as much as an ounce! Patrin had seen a founder in Germany take more than a drachm of powder of copper in a glass of brandy, saying it was good for the severest rheumatism; and to my great surprise,

prise, he adds, he was not at all incommoded by it. Rouelle, in his lectures, exhibited locks of hair, as green as if they had been dyed with verdegris, which had been cut from the head of a founder eighty-three years of age, whom he met with in a foundry at De Vosges. What a quantity of powder of copper this man must have swallowed in the course of a long life! The small leaden shot which is used to kill our game always contains a small quantity of arsenic, yet it has never been found injurious; therefore, since lead mixed with tin must certainly be less hurtful than lead mixed with arsenic, I think we may rest perfectly satisfied that the very trifling quantity of lead which we are probably in the habit of taking with our food can never be sufficient to affect our health.

EXPERIMENTS.

I. An alloy of lead and tin, in equal parts, reduced to filings, and boiled for two hours in distilled vinegar, yielded only a small portion of tin. Such a solution might be taken internally without fear.

II. Two small copper pans, tinned with this alloy, have been kept to the fire for an hour, one filled with vinegar, the other with water, and three lemons sliced into it; the vessels were kept full by adding to the liquids as they evaporated. The two decoctions withdrawn, and carefully examined, exhibited only a small portion of tin in solution; and I would have used it to dress salads and ragouts without the least hesitation.

III. To promote the action of the acid, I digested some leaves of tin and lead for two hours in a matrass with distilled vinegar; which, upon subsequent examination, was found to contain tin, but no lead.

IV. I boiled for one hour some leaves of lead in distilled vinegar, by which some lead was dissolved, as might be

be expected. But having afterwards boiled this solution with leaves of tin of equal weight, the lead was successively precipitated, until only tin remained in the solution.

V. I have shewn in my treatise, that a copper pan tinned with equal parts of lead and tin, which is certainly as bad a tinning as is made, cannot, as it comes from the hands of the workman, yield more than a few particles, which if swallowed with the food, are too trifling to cause any pernicious effects.

To defeat at once the prejudices on this subject, I took a drachm of this composition, in equal parts, in coffee; the day following I repeated the same breakfast, and did not feel at all incommoded by it. However, the quantity of tinning that I took was equal to what is used to tin a copper pan, whose surface is equal to a foot square, and this quantity requires at least a month's daily use in a kitchen before it will all be worn off; and even to accomplish this it would require to be scowered till the copper is perfectly bare, which we know never happens in any family.

Where then is the danger which families incur when each individual partakes of this small portion of the tinning? It would be superfluous to repeat here the arguments I have already brought forward in the work before mentioned, to shew how much the danger is exaggerated. If tinning of the lowest quality is not feared, why should that be feared which is generally used, and which is so much superior.

VI. Since these researches were made, I have recommenced some others of the same kind, which I shall place here.

The two experiments undertaken with lemon and white vinegar upon tinnings of equal parts of lead and tin have been

been repeated on copper pans newly tinned with the same alloy, and the results are still the same.

VII. I caused a tinning to be made of three parts of lead and one of tin. This time the results were more surprising; I could discover no lead in the liquor of these copper pans. The decoctions lasted but half an hour, because, had they boiled longer, the lemons would have been too soft, and the filtration would have been too slow.

The sulphurated hydrogene applied to these liquors gave them a brown shade, which at first would make one suppose that they contained lead; but two days after they became quite yellow, which is the colour tin always gives when the atmosphere has raised it to its highest state of oxydation, and it is well known that the atmosphere causes no change in that of lead.

VIII. There are other experiments which I think will demonstrate, that even if vinegar and lemon would have as much effect as mineral acids, the lead which they could hold in solution would be so trifling as to have little or no ill effects, even if it were used without apprehension as a seasoning.

In a copper pan tinned with equal parts, I boiled, full half an hour, muriatic acid of near two degrees of the areometer, an acid which sets the teeth an edge much sooner than the juice of lemon. When taken out of the vessel, and sufficiently cooled, I added to it sulphate of potash; the mixture became clouded, and caused a precipitation of sulphate of lead, and that weighed two grains barely. The quantity of muriatic acid was a pound, and I took care to add water to it as it evaporated, to keep the vessel full.

The same experiment was repeated with sulphuric acid, of two degrees; the liquor when taken out, after

boiling half an hour, had a slight milky appearance; it took three days to clear itself, and its deposit when collected weighed barely a grain.

The muriatic solution, separated from the sulphate of lead, precipitated a brown colour with sulphurated hydrogene; but three days after it precipitated only yellow. The oxydation of the tin was at its maximum; for the sulphuric acid held so little tin in an experiment of this kind, that it scarcely changed its colour with the sulphurated hydrogene. If, however, we examine the action of the muriatic acid on an alloy of which the two metals are separately so soluble, would it not be expected to see the tinning reduced very rapidly by a similar test? However, notwithstanding its thinness, considering also that the lead predominates in it, and notwithstanding its extreme tenacity, the tinning retained all its polish, all its whiteness, and the copper was in no part laid bare.

IX. I have said, that the danger to which we should be exposed by the use of such a solution would be very trifling. Let us suppose, for instance, that each pound of this muriatic vinegar was divided into sixteen parts, or sixteen ounces; that each of them were used in the dressing of a salad, a ragout, &c.; each ounce of this vinegar would contain but an eighth of a grain of salt of lead. Those who would persuade us that an eighth of a grain is pernicious when dispersed in a quantity of food, taken by five, two, or one person, should at least begin by demonstrating, that the salts of lead are, when of equal weight, eight times more dangerous than the corrosive sublimate, a grain of which may be taken every day without the least risk of cholic.

I mean to say, that mineral acids, of the same strength as those which I made use of in this experiment, can have no sensible effect upon the health: and I think that no

person

person who sees these experiments can persist in the belief, that vinegar and lemons can extract poison from tinning and pewter. I have shewn in my former treatise, that out of thirteen houses which sold lemon-juice and verjuice, eleven were found who sold them with lead in solution. This passage, which more than any other discovers the dreadful cause of so many cholics, seems not to have been attended to. Poison is sought where it does not exist; and where it does, it is quietly suffered to pursue its ravages. Thus we draw from our experiments, that naked copper, exposed to the action of mineral acids, is not in the least hurtful when tin is present, either in one or the other.

X. Leaves of copper and of tin were boiled in a matrass with marine acid, at ten degrees by the areometer of Beaumé; it dissolved the tin, as might be expected, but not an atom of the copper: on the contrary, the copper became white, was tinned, and the acid made not the least impression on it; it is even by this method that small pieces of brass are tinned.

Potash applied to this solution, precipitated and redissolved the oxyd of tin, but no copper was visible, neither was its presence indicated by the use of ammoniac. However, if the tin of this experiment be suppressed, the copper dissolves easily. This result then increases our confidence on this subject beyond our most sanguine hopes: it convinces us of the safety of tinning when, as sometimes happens, the tin is in some places worn off; for it demonstrates that the acid, far from attacking the copper, would repair the tinning where it fails.

XI. It is well known, that both in towns and country places preserves of all sorts are prepared in kettles of copper or brass. This custom, which at first sight ap-

pears so blameable, ceases to be feared when it is chemically examined.

A very simple experiment will furnish all the theory that is necessary in domestic economy to remove all fear. A pan of red copper, full of white vinegar, was made to boil very fast for an hour, care being taken to add warm water as the liquid diminished; it was then decanted and left to cool. If this vinegar be actually examined with sulphurated hydrogene, the most sensible re-active for discovering the smallest portion of metal, the quantity found is so very trifling as to be next to nothing, since it is impossible to precipitate it, and collect it for the purpose of being weighed.

XII. Desirous, nevertheless, to estimate it at least by approximation, I had recourse to the following experiment. I dissolved in a pound of vinegar, (which was the weight of that used in the foregoing experiment,) half a grain of verdegris, proposing to augment the quantity till the solution became such as to give, with sulphurated hydrogene, a shade similar to that which the digested vinegar gave. But I had no occasion to augment it, for what I had already prepared agreed so well with the other as to be perfectly satisfactory.

XIII. The verdegris of which I made use, held thirty-six hundredths, or about a third of its weight, in metal. The pound of vinegar, therefore, when boiled, contained only a third of half a grain of copper in solution, or, in other words, the sixth part of a grain; and consequently an ounce of the vinegar, which is about the quantity usually put to a salad for one person, would contain a ninety-sixth part of a grain, or rather a thirty-second part, of verdegris. If there be still any remaining objections against such small portions of copper as to cause uneasiness, I have the satisfaction to believe that they will

will not be encouraged by well-informed medical men: they know too well, that what are poisons in large doses often become valuable medicines in small ones; and that below a certain quantity the human body has in reality nothing to fear from their influence. They prescribe at this day ammoniacal copper with as much success as confidence. Would they do this if they were not well assured that the oxyds of mercury, silver, copper, lead, sublimate, arsenic, opium, &c. are poisonous, medicinal, or without effect, according to the dose taken?

XIV. Nature has wisely provided, that venomous productions cannot beyond a certain point affect the digestive organs of the human body. Without this power of changing their qualities in proportion to their quantities, there would be very few poisons which could be touched with impunity, even in the smallest quantities; and very few arts could be exercised but at the risk of life. No one then would dare to expose himself to the extraction of mineral acids, to the preparation of corrosive sublimate, arsenic, and verdegris, to brave the effluvia of mines and noxious airs, if a few particles, which the greatest possible care cannot prevent from escaping into the atmosphere, were capable of attacking the vital principle. The air that we breathe, the water that we drink, the variety of odours that we inhale, the food that nourishes us, would all become suspected, since there are very few which do not contain tannin, extractive matter, acids, alkalies, aromatic oils, &c. &c. substances very deleterious if taken in a concentrated state.

By these results it is not my intention to weaken the apprehensions that exist with respect to copper, which oxydation always renders so dangerous, that the slightest inadvertence might transform to poison; my views are solely

solely to estimate the degree of fear generally felt in the above cases. Thus it is out of doubt that the safety with which acid fruits are prepared for confectionary all over Europe in copper vessels is as well founded as it can be, since the custom which we recommend, of never suffering the fruit to remain in the vessel after boiled is carefully attended to, and this is an attention which is so well understood to be necessary by every confectioner and every mistress of a family, that we have no occasion to dwell upon it here.

XV. But after having endeavoured to prove that there is more exaggeration than truth in what has been repeated from age to age of the dangerous quality of copper as a metal, I think it will not be misplaced to retrace also, in the account of a few experiments, the astonishing rapidity with which it can poison our food, if we lose sight for an instant of its constant disposition to change its state, or, in other terms, to become oxydated.

An ounce of distilled vinegar was poured into a copper pan, made to hold about a pound of water; all the surface was wetted with this vinegar, and left to itself for two minutes. Six glasses were placed near it, and a bottle of hydro-sulphurated water.

At the end of two minutes the vinegar was passed over the whole surface of the copper pan as if to rince it, and then about a drachm of it was poured into the first glass. It was then left for four minutes, rinced as before, and the same quantity poured into the second glass. At the end of six, eight, ten, and fifteen minutes, the like quantity was poured respectively into the third, fourth, fifth, and sixth glasses.

To discover actually the progress that the oxydation of the metal could make in so short a space, and to ascertain it by the eye and the touch; a few drops of the hydro-

hydro-sulphurated water * were added to each of these glasses, and it was immediately perceptible that all at the same instant became of a chesnut colour, which is a certain proof of the presence of copper: the colour already visible in the first became rapidly deeper in the second, the third, the fourth, and the fifth; so much so, as to be the colour of coffee. As for the sixth, the shade was not only still darker, but the green colour, which so plainly indicates the presence of the poison, was also very evident.

XVI. Every one knows that this golden tint is very different from that which copper takes immediately after the passage of vinegar over it; it is only the effect of the metallic effusion seen through an orange yellow; or this colour is the same as that which I have found in the oxyd of copper at its minimum. This tint passes from yellow to a dark brown, and it is the oxyd which raises it from minimum to maximum; thus all becomes evident as the principles unfold themselves.

These results, well known to chemists, though not so to the world in general, are of the greatest importance to all classes of society; and the advantages derived from

* Five crystal vessels, made to hold twenty pounds of water each, are filled; and two grains and a half of verdegris, dissolved in a little muriatic acid, and which are equal to a grain of copper, are distributed among them; two ounces of hydro-sulphurated water are afterwards poured into them; the water soon becomes coloured, and, from its shade, it may be judged that, if the liquor were doubled, it would be very much speckled.

One hundred and twenty pounds of water contain one million five hundred thousand nine hundred and twenty grains of water; and sulphurated hydrogen will very easily discover the millionth part of a grain of copper, and much less.

them

them are so evidently demonstrated as to be calculated to fix the attention of the most indifferent persons, since it makes them acquainted with, or puts within their reach, the theory of metallic oxydation, by causing them to comprehend, through this gradation of shades, the surprising rapidity with which acids that have no effect upon copper, convert it into poison whenever the oxygen of the atmosphere combines their affinities with its own. The operation of our arts, which has for its object the conversion of copper into verdegris, is founded on such experiments as the above; and the expression so often used of "it is made of verdegris," is more literal than we are apt to imagine.

XVII. Not only vegetable acids have the most dreadful effects on copper as soon as their affinities are assisted by that of the oxygene of the atmosphere, but salt itself, under the same circumstances, becomes equally pernicious; it is decomposed by contact with the metal, and produces that green combination known by the name of *muriate of copper* with the minimum of acid, the effects of which would not be less formidable than verdegris. It appears that during this contact the copper, as it becomes oxydated, effects the decomposition of the salt, and sets a part of its base free, whilst the acid unites to the oxyd; for the salt which before this takes place would not change the colour of violets, will make them green soon after it has produced this species of verdegris.

XVIII. Fat substances of all kinds, assisted by the oxydizing principle of the atmosphere, as much as by that which, according to Berthollet, they contain within themselves, act, as is well known, with equal celerity on copper.

It

It was indeed the combined action of grease and marine salt that occasioned the quick corrosion and destruction of the copper-sheathing of vessels so much complained of in the ports of Spain. It was thought to proceed from some error in the refining, till Don Raphaël Clavigo, an officer who possessed a great deal of general and solid information, discovered the cause, which till his time had been unsuccessfully sought for by chemical analasis. It occurred to him, to place sheets of thick coarse paper between the plaster of fat and the copper, to prevent their contact; and from that moment the durability of the sheathings were secured.

XIX. But to return to the subject of copper considered as a metal; it may certainly be used with safety to dress the greatest part of our food without the least risk of injuring the health, since vinegar, which does not yield to any acid fruit in activity, may be boiled for a long time without dissolving any appreciable quantity. But the instant when the liquid ceases to cover the copper, when the heat ceases to hold the oxygen in that dilatation and separation, which opposes its action, and weakens its affinities, these same affinities and that of the acid imperiously resume their action, and then the danger commences. It is not owing to the food having been dressed in vessels badly tinned that so many poor people have fallen victims to this metal, but when from negligence, or from being unprovided with a change of vessels, they have suffered the food to remain in the vessels until the next day.

But, besides, culinary operations are not of a nature to require a long-continued boiling, and the operation of stewing can only be effected by a lower degree of temperature, which certainly is not the most

proper to prevent oxydation; for the fat substances which compose a part of the food are of themselves too much disposed to attack the copper, without the assistance of the oxydizing principle of the atmosphere, to permit this metal to be tolerated in our kitchens. If a quarter of an hour is enough to convert an ounce of vinegar into poison, it is very evident what would be the consequence of suffering a quantity of food to remain in a copper vessel for eight or ten hours.

In the making of sugar, in pharmacy, in confectionary, it is quite another thing; these preparations are all kept boiling without intermission, except when passed into other vessels to be cooled, and in these preparations the fat substances never make a part. The wear of the copper in these cases is not to be compared to that which it has in kitchens, even when tinning is not used.

But since in the service of kitchens numberless causes unite to accelerate the dissolution of the copper; since the juices of all viands are fat, acid, and naturally saline; since there is no fruit or vegetable which does not contain one of these qualities, and even the herbage of our meadows, which, as Fourcroy remarks, will not redden the turnsol; it is therefore evident, that tinning is as indispensable for kitchen utensils as it is useless in large apparatus, on account of its quick wear and short duration.

TO BE CONCLUDED IN OUR NEXT.

On the Alum Ore of Tolfa: in a Letter to M. Berthollet, *from M.* Gay-Lussac.

From the Annales de Chimie.

PERMIT me to communicate to you some experiments which M. Morichini and myself have made upon the alum ore of Tolfa. You know that it is sufficient to calcine, and then to expose to air for 2 months, the alum ore of Tolfa, and during that period to water it several times a day, to keep it constantly moist. At the second day the alum begins to develope itself; and when the earth is pure, and has been properly calcined, it becomes finished by changing into a sort of paste when it is washed with the least quantity of hot water that will extract the whole of the salt. It is not necessary to add any thing to the lessive, nor even to the mother water, which is sufficiently pure to allow all the alum to be obtained in a fine state by evaporation; but the mother water may be advantageously used for washing new paste. Though the ore contains oxyd of iron, which often gives it a red colour, it is so oxydated as to be insoluble, and it is this property principally which occasions the alum to be in so much request. It appears, therefore, that the stone of Tolfa contains an exact proportion of all the principles of alum; and if, in the siliceous residue which is left, alumine is found, it is probably owing to the decomposition of the salt by the fire.

From this short account of the operations the stone is made to undergo, it may be asked upon what they are founded, and what passes during the time. Before replying, we shall remark that the stone is very compact, and that, from the analysis of M. Vauquelin, it contains a considerable proportion of silex: pulverized and washed

with boiling water it loses nothing, and diluted sulphuric acid attacks it but very weakly. Still, however, when it undergoes the first operation, which consists in a calcination in a red heat, much water and sulphurous acid vapour is disengaged. The stone consequently loses part of its weight, and from being hard and compact becomes friable and porous. Washed with water it then gives a little alum; but moistened, or even put under water for some time, it swells, and furnishes alum abundantly. Inclosed with a little water in a certain quantity of air, the salt developes itself equally well, though the air suffers no change either in its quality or quantity. The alum therefore appears to be already formed after the calcination, and it would appear that this operation has for its object only to convert the sulphur into acid; but it is easy to shew that this is not the case.

We have treated the ore of Tolfa with potash; if it had contained sulphur, the alkali, by dissolving all the mass, must have formed some sulphate and sulphurated hydrogene; but though it was tried several times, it was not possible to discover an atom of either sulphur or hydrogene. The quantity of sulphuric acid, on the contrary, was very considerable; for the liquor, after having been saturated, precipitated very abundantly solutions of lead and byrites. Since the ore contains only sulphuric acid, it is not possible to explain the sulphurous odour which is observed in the calcination by the combustion of the sulphur; but we shall shew below what the cause really is.

Why, therefore, is the calcination necessary if the acid is already formed, and why cannot alum be directly extracted from it? We reply, that it contains a considerable proportion of silex which is intimately combined with

with it, and then we conceive that all the elements of the ore act upon each other; the sulphuric acid also acts upon the silex and the alumine; that is, it is combined with more base than it can saturate. Therefore, this base being insoluble, the composition ought to be so likewise; and the same effect ought to take place as if the silex had been replaced by alumine. Now, to give an explanation, the fire expels the water contained in the stone, destroys mechanically its aggregation, or dilating unequally the alum and the silex, it effects the same thing. Whatever may be the case, one cannot doubt the action of the silex on the alum, for in the ore this earth is the only substance which can oppose itself to the dissolution of the salt.

As to the exposure of the ore to the air after calcination, since it has been shewn that the acid is already formed, and that the stone then yields alum, it appears that the only object is to give time for the water to penetrate it; but in the same manner as lime is slacked better with a little water than when immersed in this fluid, so it happens with this ore, which is better with being simply moistened.

We have seen that the sulphurous vapour which exhales during the calcination of the ore cannot be owing to the combustion of sulphur; but it may be supposed that the alum is decomposed by the heat, and that its acid may be converted into the sulphurous by the carbonaceous vapours which the fuel continually supplies. Before we determine we must still consult experiment.

We have distilled in a coated glass retort some of the alum ore, which was very pure, and had not undergone the calcination. As soon as the retort became red hot, a little inflammable gas, burning blue, was disengaged; and then a very great quantity of sulphurous acid gas, mixed with

Such are the experiments we have made upon the ore of Tolfa. They leave much yet to be done; but the little time we have been able to devote to the subject since my return from Tolfa to Rome, has prevented us from giving them that precision we are sensible they want, as well as of making others, which we have suggested since. For it would doubtless be useful to see, if in the same sort of manner as the nitrates are changed into nitrites by the action of fire, alum is not changed into sulphite; and besides, of enquiring whether the other sulphates which are not susceptible of perfect neutralization, such as the acid sulphates of alumine, glucine, &c. may undergo a similar decomposition to that of alum.

Of the Thermo-Poële or Stove for burning the gaseous Parts of Fuel, and on the best Method of burning Wood.*

By CHRETIEN FREDERIC WARNER, *of Saxony.*

With a Plate.

From SONNINI'S JOURNAL.

DURING the combustion of wood in the open air, it disengages a greater or less quantity of smoke according as it is moist or dry; from whence it follows that smoke is partly composed of aqueous vapours, since moist wood yields more smoke than that which is dry.

The smoke deposits on all the substances with which it comes in contact a quantity of resinous matter and of

* There having been no account yet published in England of any apparatus for burning the inflammable products of fuel at a distance from the fire-place, nor any explicit directions as to the method of constructing them; not even in the specification of the patent which claims exclusive right to the invention, for which see our fourth volume of the present series page 172; it is presumed that the information contained in this paper on the subject will be highly acceptable to our readers.

disengaged before the other; but as we have always obtained them together, we cannot say which is disengaged first.

We now see, from what precedes, that the sulphurous odour which is perceived during the calcination of the ore, is owing to the decomposition of the acid of the alum of the ore. We may therefore conclude, that the more sulphurous acid is disengaged the more alumine is left uncombined. In the method of calcination now practised, pieces of the stone are employed nearly as large as one's fist, and sometimes larger: it follows, therefore, that some alum must be decomposed, as it is impossible that the interior of the pieces can have the same degree of heat as the exterior. M. Regny, director of the manufactory, told us that this calcination was very delicate, and that it could only be done in the night, because that operation was shewn to be at an end by a sort of light bubbling on the surface of the stone, and by a change of colour. If the calcination is not carried far enough, there is one part of the ore which yields no alum; if, on the contrary, it be pushed too far, the salt is decomposed, which takes place as soon as any sulphurous smell is perceived. This decomposition is not only shewn by the alumine which is found in the residue, and by the cubic alum which is collected in the reservoirs which receive the mother water, but M. Regny told us that it sometimes happened that if the aluminous solution was too much boiled in the cauldron, there would be a deposition of insoluble alum, or alum saturated with its base. The residue, however, appears not to contain much alumine, and, as M. Regny has made several useful alterations in the manufactory, there will be less still in future. But we cannot but believe, that if the construction of the furnaces for calcination was altered, and the ore reduced to smaller pieces, it would be very advantageous.

Such

For this purpose, the wood is burned in an inclosed place, and by this means all its parts are successively extracted to the charcoal. All these parts thus disengaged are made to pass into a cold place, where the aqueous vapours, and those of an oily or resinous nature, are condensed; the soot is also deposited; the aqueous vapours produce ligneous acid; the other parts yield tar and oil. The remainder which is not decomposed, consists of smoke purified and rendered combustible. This smoke may be conducted any where desired; in the open air it takes fire as soon as it comes in contact with flame. In an inclosed place it may be burned as slowly as any other kind of fuel; this is one of the most important circumstances in the operation, without which the combustion might occasion too much danger.

The stove may be constructed in different manners, according to circumstances; the following is the most simple; if it is desired to use a stove which is already formed, there should be placed within it a case either of sheet iron, or cast metal; the latter will last longer, but is more liable to be cracked by the transitions from heat to cold.

Two apertures should be given to it, one for putting in the fuel and taking out the charcoal; the other for the passage of the smoke.

The junctures of the case should be carefully luted, to prevent the escape of the smoke. To form the luten, equal parts of moistened and of calcined clay are to be used, mixed with the same quantity of iron scales from the anvil, and the whole brought to a paste with ox blood.

The case which I made use of, was an ell and six inches long, its breadth 18 inches, and its height 12 inches: Its capacity was nearly a cubic half ell. By its operation a chamber of moderate size may be kept warm for six hours

hours (with one charge). It is impossible to state precisely the proper size of the case in proportion to the chamber, but in general it is better that it should rather exceed in dimensions, for thus it will seldomer require to have the charcoal removed and receive a fresh charge of wood.

The case should be placed so in the stove that the fire may act on it with the greatest force; and should at most be but five or six inches above the grate, so that that there should only remain between them the space necessary for putting in the fuel.

The neck of the case (through which the wood is to be introduced) ought to pass through the side of the stove in the part most convenient for its use. The aperture of this neck should be closed with a cover formed with a projecting rim made to fit into a groove formed in the edge of the neck, which groove should be filled with fine sand; The rim of the cover should be forced into this sand, and then it should be bolted down. By this means any luting for this part is unnecessary, since the sand closes all the junctures so exactly that no smoke can escape. A tube, for conveying off the heated vapour, passes from this carbonizing case through the side of the stove to vessels of refrigeration for condensing it.

People in the country like to have in their kitchen, or room where they reside, stew-pans, kettles and pots fixed in the stoves; in such places the vessels for refrigeration should be placed in the chamber itself. The smoke-tube from the carbonizing case passes into the first refrigerating vessel, from thence into a second, and afterwards into a third; being purified and cooled in these vessels it then returns by another tube to beneath the carbonizing case, over the fire place, where it burns with a strong flame; and there is but little fuel required to

continue the carbonisation of the wood in the case without interruption.

The wood thus carbonises itself by its own smoke, separated from it, and inflamed in a manner more perfect than the ordinary method, and at the same time warms the chamber.

All the heat which is commonly dispersed with the smoke in common chimnies, partly disengaged from the smoke, and partly united to it, is thus retained and applied to profit, as well as the oil, the tar and the ligneous acid, which altogether are equal to half the value of the wood.

When there is neither a grate to the stove, nor a current of air established through it, a greater supply of fuel is necessary. The stove represented in Fig. 1, intended for a country or cottage kitchen, affords an easy method of having both these. There are formed in it two passages for air; the one, communicating with the chamber, has the advantage of purifying the air more; but as the currents it occasions at the same time draw off the heat of the chamber, this passage is stopped by a door of sheet-iron during the winter when the cold is considerable; and a second passage *a* to the outside of the chamber is then opened. By these currents of air more ashes than usual are obtained from the wood.

Country people also like to have the door of the stove in the same chamber, to introduce the wood into it; this is a matter of indifference, and all that is necessary is, to take care that the door of the stove may be lower than the passage for the smoke. But since the *Thermo-poële* produces charcoal continually, it would be absurd to burn wood under it instead of charcoal. From this it follows that there will be no smoke in the stove, and that any form judged proper may be given to the door.

Another

Another method of carbonising wood in the case, more advantageous than the former, and which requires a smaller addition of fuel, is that in which the flame is reversed; by which it acts with greater force on the front of the carbonising case. Fig. 2. In this method there is used a kind of advanced stove, *b b b*, and beneath it a grate, on which lighted coals are placed. To establish a current of air it is necessary to have a small door, G, in the stove. At the first, straw, paper or other matter producing a great flame, should be burned in this part, and the door then shut. The flame will then draw a current of air across the grate and beneath the case; and when once this current is established, it will continue without interruption. The smoke, as in the stove already mentioned, may be made to pass under the grate, where the lighted coals are placed, and be consumed there with a reversed flame, after it has passed through the last of the vessels of refrigeration. There may also be formed in the advanced stove another passage for the air, from the outside of the chamber, in order that the heat may be retained in it, when the door of the advanced stove is shut. The introduction of the wood into the carbonising case will be easier if the stove has the figure represented; the wood is to be introduced by the aperture A. The door B serves for taking out the ashes.

But in a chamber where the vessels of refrigeration would be inconvenient, however artfully concealed by tables, cupboards, &c. the tube from the carbonising case should be made to pass through the wall, to whatever part of the house the vessels of refrigeration could be most conveniently placed; and from thence the smoke should be conveyed back in the same manner, after having circulated through the vessels, to the fire-place, in order to be consumed. The tube may be concealed

in

in many methods, either beneath the floor or in the wall, for the smoke never gets sufficiently hot to take fire in it.

A single vessel of refrigeration, though as large as the three together, would not cool the smoke so much. The heat expands itself equally over the whole vessel, and the smoke passes off very hot through the aperture. But in the first vessel of a smaller size it loses a part of its heat, and arrives at the second less hot; and is still less warm when it arrives at the third vessel. For the carbonising case already described, of a cubic half-ell in capacity, I used two casks, each about the size of a quarter-cask for beer. But, with a strong and continued fire, the smoke would not be sufficiently purified by them in the end. This is not of any consequence if it is to be burned in the stove; but if it is intended to be burned in the open air, to give light, it will still produce an odour, which is a proof that it is not sufficiently cooled or purified.

These vessels of refrigeration are filled with water almost up to the bottom of the pots which serve them for covers, Fig. 1, C, and which continually produce the refrigeration. By means of these pots the cottager may always have water heated to three different degrees, proper for domestic uses, without any expense, and will no longer have occasion for kettles formed in the stoves. To promote the refrigeration of the smoke more, and at the same time put the heat to profit, it will be advantageous to form the upper part of the vessels *c c* with thin sheet iron, that the heat may more easily penetrate. By this means the vessel of refrigeration will itself become a sort of stove, which gives out a continual heat.

To make the sheet-iron join so to the wood that no smoke can escape, it will be sufficient to make it descend sufficiently low to touch the water, and the water will close the joints.

In

Pl. III Vol. IX. Second Series

Fig. 1.

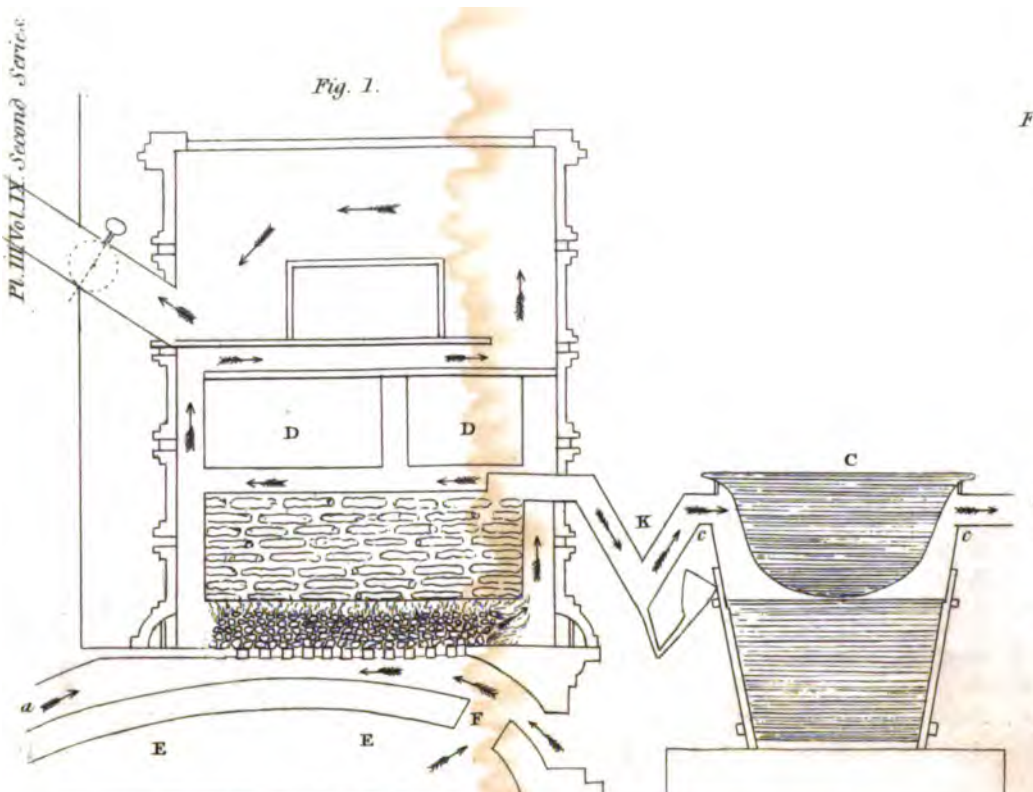
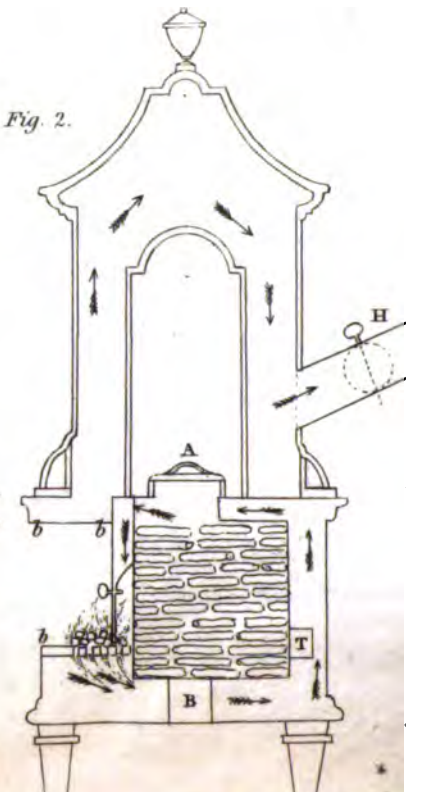


Fig. 2.



In these refrigeratories there is obtained a rich product in a short time: the oil swims at the surface of the water, the tar falls to the bottom, and the ligneous acid mixes with the water. At present there is no certain use discovered for this acid. It is possible it may be found of service in tanning, but in the mean time it forms a manure preferable to wood ashes.

Accordingly as the fire is made stronger or weaker, the vessels should be emptied in six or eight days, by means of a spigot, and filled with fresh water by a tunnel, with a curved neck, through a hole made in the cask above the level of the water; this hole should be afterwards closed by a stopper of cork.

The tube which, proceeding from the carbonizing case, passes to the first refrigeratory, should be of iron or copper, because it acquires considerable heat; it ought also to be made sufficiently large that the smoke, in proportion as it is driven forwards, may pass through it rapidly; otherwise the heat will consume a part of it. When the carbonizing case is a cubic cell in size, the tube ought to be at least four inches in diameter. The tubes of communication between the refrigeratories and the tube which convey back the smoke to be burned, may be made of any substance, even of wood, if it is thought fit.

The easiest method of constructing these tubes is to make them square, by combining four laths, made to fit close, and covering the four joints with paper, so that the smoke may not penetrate through. But at the inside they must be covered with a coat of oil paint, as it seemed to me that the smoke penetrated through the pores of the wood when it was not thus covered with paint. As to the orifice of the tube, at the end where the

the smoke is to be kindled, it ought always to be made of metal, for five or six inches in length, because it is strongly heated in this part by the flame of the burning smoke. The tube which brings back the smoke to be burned need not be so large as the other; and four square inches aperture will be sufficient for it. The metallic termination ought to diminish from four inches to an inch and a half in diameter. As all the smoke from a carbonizing case of a cubic ell can pass through this aperture, it would be useless to make the tubes larger.

In order to give light to the chamber also, a valve is applied to the tube through which the smoke passes, by which it may be either closed entirely or in part. Behind this valve another tube is placed, with a termination of metal, of the diameter of the eighteenth or twelfth of an inch. This tube may be brought on to any part of the chamber, and may be made of leather, and be moveable. The place of the light may thus be changed at pleasure: the tube may be made to ascend along the walls, and pass over to the middle of the ceiling, whence it may be made to descend in a lustre of six or twelve branches indifferently. In this manner the cottager may light up his chamber free of expense, and in the most agreeable manner.

There may be fixed above the carbonizing case all sorts of conveniencies for boiling and roasting D D, in the most various manners, according to the wants of each family. The stove, Fig. 2, where the fire burns with a reversed flame, affords besides the great advantage, that in the advanced stove one may boil, broil on the coals, or roast whatever is thought fit, and with great quickness. This stove then deserves to be preferred to the other on this account singly: and I would not have recommended the other, if I was not afraid to deter the cottagers

tagers from its use by the expense, since it must be entirely constructed of iron materials; while the other may be set up in using the old stove, in which it is only necessary to place a carbonizing case.

Whenever a new stove is erected, an oven should be constructed beneath it, as in Fig. 1, E E. When it is required to heat the oven, the air-passages are to be stopped, and the door F in the upper part of the oven is to be opened. A quantity of lighted coals are to be placed at the entrance of the oven, and the tube is to be opened which conveys the combustible smoke to it; and thus the oven is heated, the chamber warmed, and the wood reduced to charcoal, by means of the heat which is usually lost.

It is not possible to manage the heating of chambers in a better manner for the country than that described. The wood is decomposed into its constituent parts, which are all put to profit in the most perfect manner; none of its parts are lost.

As to the refrigeratories, they must be always inconvenient and disagreeable to the inhabitants of cities, in whatever place they may be put. But in this case they may be entirely omitted, and the smoke nevertheless be burned. It is only necessary to resign the advantages of lighting the chamber, and collecting the oil, the resin, and the ligneous acid; for the smoke, when it is not purified, does not burn in the open air, or is only burned partially, and leaves a vapour, soot, and a bad odour, arising from the parts which compose the resin, the oil, and the ligneous acid.

The tube, Fig. 2, *b*, which for the greater convenience may be rectangular, large at one side and narrow at the other, descends at the front of the carbonizing case, and passes to the fire-place. There the smoke is

consumed, together with all its oily and resinous particles, in the same state in which it is disengaged; but its aqueous particles, which cannot be burned, are carried off along with the deleterious vapours of the charcoal by means of the tube which passes to the chimney.

The valve H, Fig. 2, of this tube serves also to regulate the flame, which may by its means be diminished or increased. The resin and oil are not entirely lost, as they are consumed as combustibles. It is true they might be managed so as to produce more profit, but every one is at liberty to prefer conveniency to advantage, or advantage to conveniency. At the aperture of the tube which conducts the smoke from the carbonizing case into the fire, a screw is placed, which serves to shut the opening; without which the smoke, when in a state of stagnation, would burn in a retrograde direction, and set fire to the charcoal contained in the case. A stove of a more complicated nature, in which the heated air should make more turns, in order to give out the heat, would be useless. The air is not capable of holding so great a charge of heat as the smoke, which is a more dense substance; and this is the reason why the air cools more quickly.

This disposition of the stove will serve well for a family which has only one chamber to warm and to light.

But in great houses, where there are many apartments, the *Thermo-poële* should be placed in the kitchen, and the refrigeratories in the wash-house; and the chambers should be warmed solely by the inflammable smoke caused to pass into them; and which may either be made to burn as a fire in the chimney, or caused to represent a flame on an altar, or other devices; so that in them there would be no occasion for a stove. Art has a vast field to

adopt

adopt elegant and varied forms of all sorts in this operation. If the light of the fire should be too dazzling, it might be softened by glass of different colours, which will give it a more beautiful aspect. But those who nevertheless prefer the stove, or who fear the odour and the vapour, may cause the stove to be warmed solely by smoke already burned.

But, in order to heat a chamber to any required degree, and also because the smoke entering into the chamber without being burned is extremely disagreeable, it is necessary that a sort of cock should be fixed near the aperture where the smoke is burned, which should fit tight. At the instant when this aperture should be opened by the cock, the smoke which passes out should be kindled before it could escape into the chamber. The aperture of the cock should be greater than the orifice of the tube; so that a flame more or less great may be produced, or the tube entirely closed.

For a chamber of moderate size, it is necessary that the tube of communication from the last refrigeratory to the metallic orifice should be of the width of four square inches. The orifice being contracted to one inch, the smoke must then advance in the tube of communication one inch, for every four cubic inches burned in the chamber. The increased size of the orifice has less effect than the rapid circulation of the smoke; when the fire is increased, the smoke then being disengaged in a greater quantity, circulates more rapidly. A smaller aperture and a more rapid circulation may produce a larger flame, and a greater heat, than a great aperture and a slow circulation. The quickness of the movement multiplied by the aperture gives the product of the smoke burned. If four cubic inches of smoke are burned in a second, there will be eight cubic feet and a third burned

in one hour, and 133 cubic feet and a third in six hours.

If three or four chambers are to be heated and lighted at the same time, the size of the tube of communication should be eight, twelve, or sixteen cubic inches, as far as the place where the tubes branch off from it to pass to the different chambers.

When it is desired to warm several chambers at once with the combustible smoke a larger carbonising case will be necessary; and a large fire will be required to heat this great case. But, to economise the fuel, it may be more advantageous to surround the fire with wood than the wood with fire. In this way, the sides of the carbonising case may be made solely of bricks; and the bottom, top, and an interior cone, where the fire should be burned, may, along with the grate, be made of iron. An oven may also be contrived under this carbonising furnace, in the manner already described. Above it places may be constructed for boiling or roasting, similar to those marked D D in Fig. 1, of different forms, according to pleasure; and the top of the whole may serve as a sand-bath, on which dressed dishes may be kept warm. In this manner a single fire-place may be sufficient for every purpose in an house.

The refrigeratories, and other parts of the apparatus, ought to be large in proportion to the size of the carbonising case. It is better to make the refrigeratories too large than too small. It is true that the long circuit which the smoke must make will cool it sufficiently, and that it will arrive at the chamber consequently in a proper state of purity; but whatever it has not deposited in the refrigeratories must be left in the tubes, which will finally obstruct them entirely.

In order that the person who takes care of the fire in the kitchen may also know the degree of heat in the chambers;

chambers; where the pipe of communication passes through the kitchen, a small tube should project from it into a glass lanthorn, that the wind may not blow out the flame of this lamp, which should burn continually. The flame of the burning smoke at this small tube will shew every instant the state of the smoke in the tubes. If this flame becomes feeble, it will be necessary to augment the fire, or otherwise the chambers will be deprived of the combustible smoke. But if the persons who are in the chambers shut the cocks of the pipes in them more or less, the tubes will be overcharged with smoke, and the flame in the lanthorn will grow long and vivid: for this reason a tube of reserve should be provided, fitted with a cock, which should pass above the fire-place from the lower part of the carbonizing case. If there is too much smoke in the tubes, on opening the cock the overplus of smoke will be discharged into the fire, where it will act to profit in the same way as in the chamber stoves, in carbonizing a proportionate quantity of wood. This same method may be used in summer time, when the chambers neither require to be warmed or lighted. In this manner the person who is in the kitchen may know how to manage every thing by the lamp. When this lamp burns, all the fires in the chambers burn also; and according to its direction the fire may be increased or diminished to the satisfaction of those in the chambers.

In proportion as the wood becomes carbonized the flame grows more feeble; but the chambers will be deprived of a supply of the combustible smoke for some time, when fresh wood is put into the carbonizing case; for this reason, a reservoir for the smoke will be necessary; and the best model for it would be the bellows of an organ. It might be placed in any corner thought fit, either in the wall or beneath the roof. It is not necessary that it should

should be made of costly materials; old linen, covered with paper, might serve for it in place of leather; it might be of any size thought fit, large or small; its sole use would be to cause the smoke which it contained to enter the tube by an equal pressure. It would thus supply the place of the carbonizing furnace until this furnace should be filled afresh, and at work.

Its mechanism is so simple, and susceptible of so many varied forms, that it would be useless to give here a more detailed description. The tube from the last refrigeratory should pass immediately into the reservoir, and from it to the chambers. This reservoir should be opened in the morning, in order that it may be filled with smoke, before the chambers are heated, and it should be left in this state, to be used as it is wanted. When the carbonisation was proceeding, and the chambers warmed, so that the persons who occupied them would by degrees close the cocks of communication; and the smoke that was not used should become accumulated, which would be shewn by the lamp very exactly, then the reservoir, by the simple mechanism of a balance, might be made to open by degrees, and receive the superfluous smoke. In this manner, by means of a reservoir of sufficient size, all the chambers might be warmed, during a whole afternoon, without burning a single charcoal, or any other combustible.

Supposing that a chamber requires four cubic inches of smoke each second, and that there are six chambers, 50 cubic feet will be necessary every hour, and for six hours 300 cubic feet; the reservoir then ought to have a a capacity of 300 cubic feet. The cube root of 300 being $6\frac{6}{10}$, the reservoir ought to be in length, breadth and height 6 feet and $\frac{6}{10}$.

When the stove is first heated, the tubes are filled with atmospheric air. The smoke mixes with this air, and only

only passes through the orifices in the state of rarefied smoke; which, though it burns as long as a flame is held to it, will not continue to burn by itself, because it is too much rarefied, until the atmospheric air is driven out by the smoke, and it appears as thick as when it leaves the carbonising case. If it is only required to burn the smoke in the stove, this circumstance is indifferent; but is not so when it is desired to burn the smoke openly in the chamber. It is for this reason, and likewise because on opening the carbonising case the smoke might return and pass out, that a cock becomes necessary in the tube, which passes from the carbonising case into the first refrigeratory, in order to have the power of closing the tube before the carbonising case should be opened.

A metallic cock, with an orifice sufficiently large for this situation, would occasion too great an expense, especially for a cottager; but those who do not choose to go to this expense may find cheaper means for stopping the tube.

As to the cocks of the other tubes, they may be formed of wood, because they are not exposed to the heat, as the first is. The tube may also be closed by water in the following manner; let the tube in Fig. 1, K, be bent downwards in a curve somewhat more than its own diameter; at the bottom of the curve it should communicate with a small pipe, which should turn upwards and be enlarged into the form of a tunnel, and rise to the level of the top of the tube. If water is poured into the tunnel, it will rise in the great tube above the curve, and thus close it. If, on the contrary, the lower aperture of the small tube is opened, which need only be closed by a cork, the water will run out of the large tube and leave it open, and the small tube alone will be closed by the water.

When

When the smoke burns with a small flame, and only to give light, the wind easily extinguishes it; but if the orifice is formed with a kind of border, with some holes in it, so that the flame may burn partly in this inclosure, the wind cannot extinguish it so readily.

The smallest fragments of wood, and saw-dust, may be used for filling up the spaces between the large pieces of wood in the carbonising case: the smallest bits are as useful here as logs.

These stoves afford the farther advantage of preserving and smoking meat in a purified smoke; instead of which in common chimnies and stoves it is dirtied, and impregnated with the soot and resin of the wood.

It would be superfluous to say more to recommend these stoves. Their advantages are so great and so evident, that they only require to be known to be universally adopted.

Method of preparing Turkey Leather in the Crimea.

From SONNINI'S JOURNAL.

THE skins are first steeped twenty-four hours in cold water. The fleshy parts and fat are then scraped off. They are macerated ten days in lime-water, after which the hair is removed; they are then soaked for a fortnight in clean water, frequently renewed, and they are several times kneaded by treading. The last water is impregnated with dog's dung, to complete the separation of the hair; they are scraped once more, and are then considered as cleaned. After these operations, they proceed to *nourish the skins* (as the technical phrase is) by soaking them for four days in an infusion of bran, and afterwards in a luke-warm decoction of honey. The skins are then

then passed through the press, and finally steeped four days in salt water. When they are taken out they are ready for dyeing. It seems that the *artemisia annua* (annual mugwort) in decoction is the base of all the colours which are given to the Turkey leather in the Tauride, at Astracan, and in the towns which formerly belonged to Turkey. This has hitherto been kept a secret.

To dye red, cochineal in powder is mixed with the decoction of mugwort, and alum is added. After the skins have been steeped in this dye, they are kneaded in a hot infusion of oak-leaves; when they have become supple and mellow, they are passed through cold water; they are rubbed with olive-oil, and calendered with wooden cylinders.

Of a beautiful Green Colour for Painting, to be obtained from Chromium. By GODEN DE SAINT-MEMIM.

From the ANNALES DE MUSEUM.

VAUQUELIN adds, to the account of his experiments upon Chromium, the supposition that, as this metal is to be found in different parts both of the old and new world, in a variety of fossils, it may at some future period be obtained in sufficient quantities to be applied to purposes of utility; and at the same time he points out the importance of such a discovery. (*Annales de Chimie*, N° 98, vol. XXV.) The discovery of an iron mine containing chromium, in the French territory, soon confirmed this supposition, as well as the hopes of the advantages to be derived from chromium for the arts and manufactures.

I was then engaged in experiments upon this metal, in which I directed my attention particularly to the combinations of its acids or oxyds with earths, in the

hope of obtaining a not-compounded green colour, which had long been a desideratum with painters. A series of experiments has enabled me to lay before the public the following results, which afford well-grounded hopes that we shall soon see this green chromium colour, as well as other genuine ones, introduced into painting.

After having obtained by the known process a solution of chromate of kali, I dropped into it an oxydulated solution of mercury, whereby a precipitate was produced, of a beautiful red colour, which underwent little alteration in the air. Out of this combination, as it is so easily decomposed by heat, I hoped, by the addition of an earth, and with the aid of fire, to obtain the desired colour.

I therefore put three parts of chromate of mercury, and one part of alumine, into a crucible, and heated them very strongly. The result was a yellow mass, which became greenish by the contact of air, and which I discovered to be a compound of alumine and chromic acid.

This experiment, repeated with a much more intense degree of heat, gave a beautiful green colour, of a very good body, which underwent no alteration by the contact either of air or light. The prosecution of my investigation naturally led me to analyze the chromate of mercury; and this analysis I shall now describe, as a guide for those who may wish to prepare oxyd of chromium, or this green colour.

Analysis. 50 grammes of chromate of mercury were put into a retort, at the neck of which was a glass tube passing into a basin containing water, together with an apparatus for collecting gases, and exposed to a heat which at last was rendered very intense. After 50 minutes, I imagined that the whole of the mercury had passed over, and I slackened the fire. The whole of the

mercury

mercury which had passed over weighed 40 grammes, and in the retort the oxyd of chromium appeared of a very dark green colour, in the form of a light powder, weighing 6,3 grammes. The neck of the vessel was lined with a little light green oxyd, and at the same time with a red substance somewhat darker than the chromate of mercury, which however I consider to be the same combination, only under a slight modification. I have not yet determined the quantity of oxygene; but evidently the difference of 3,7, deducting the quantity of oxygene that oxydulates the mercury, must nearly constitute the difference between the oxygene of the chromic acid and that of the oxyd.

The oxyd, by mere admixture with white lead, gives already a variety of permanent colours; it seems, however, preferable to employ an earth as body for it, for it appears certain that thereby the colours of the metallic oxyds acquire more brilliancy and solidity, as we see in the instances of the Cobalt-blue, terra de Siena, &c. Besides the application of this green chromium pigment for painting in oil and water colours, it might, if mixed with the proper quantities of fusible materials, be very well adapted for painting on porcelain, without any alteration of its tints being to be apprehended from the action of the most intense heat; also for enamels, painting on glass, and fluxes, and for all kinds of pottery in general; for I am persuaded that the costs of the preparation are not too high for any manufacture of the kind.

Chromate of mercury consists therefore of:

Oxyd of chromium - -	12,6
Oxyd of mercury - - -	83
Difference of oxygene between the chromic acid and the oxyd - - - - - - - -	4,4
	100,0

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Account of the Rewards conferred by the Society for the Encouragement of Arts, Manufactures, and Commerce, on May 27, 1806.

In Agriculture.

To J. C. Curwen, Esq. M. P. Workington Hall, for Agricultural Improvements; the Gold Medal.

To Richard Phillips, Esq. Tyn-y-Rhos, near Oswestry, for improving Waste Land, Class 45; the Gold Medal.

To J. G. Calthorp, Esq. Gosberton, Lincolnshire, for the cultivation of Spring Wheat, Class 23; the Gold Medal.

To Mr. J. S. Wade, Benhull, near Saxmundham, Suffolk, for planting Osiers, Class 12; the Gold Medal.

To Charles Layton, Esq. Reedham Hall, Norfolk, for Comparative Culture of Turnips, Class 26; the Silver Medal.

To Mr. Wm. Chetham, Mellor Moor, Derbyshire, for improving Waste Land; the Silver Medal.

To Mr. Robert Salmon, Woburn, Bedfordshire, for remarks in pruning Timber Trees; the Silver Medal.

In Chemistry.

To Mr. Charles Wilson, 6, Worcester Street, Borough, for a Method of curing Damp Walls; Ten Guineas.

To Mr. Sebastian Grandi, 6, Brownlow Street, Long Acre, for Colours and Materials for Painting; the Silver Medal.

In

In Polite Arts.

To Her Serene Highness the Margravine of Brandenburg Anspach, and Bareith, &c. &c. for a Model in bas relief of the late Margrave; the Silver Medal.

To Miss Folkes, Cavendish-square, for Miniature Paintings; the Silver Medal.

To Mr. Charles Heath, Russel-place, Fitzroy-square, for an Original Sketch of the Battle of the Angels, Class 101; the greater Silver Pallet.

To Mr. J. B. Lane, 18, Upper Grosvenor-street, for an Historical Drawing of Alexander attacking the Persians, after crossing the Granicus.

To Miss H. A. Jackson, Hanover-street, Hanover-square, for a Drawing from Nature, of a Lady Bathing, Class 100; the Gold Medal.

To Miss Hillier, Stoke Park, Guildford, for a Drawing of Flowers from Nature; the greater Silver Pallet.

To Miss Francillon, Norfolk-street, for a Drawing of Flowers from Nature; the greater Silver Pallet.

To Miss S. C. Day, Lower Bryanston-street, for an original Drawing of Augustus entering the Apartment of Cleopatra; the smaller Silver Pallet.

To Mr. G. Gutch, Oxford, for a Drawing of Wrexham, Class 99; the Silver Medal.

To Mr. P. M. French, Great Alie-street, for an Architectural Drawing; the smaller Silver Pallet.

To Mr. A. Raimback, Warren-street, for a Line Engraving of Punishments in Tartarus, Class 107; the Gold Pallet.

To Mr. L. Clennel, Twickenham Common, for an Engraving on Wood of a Battle, Class 110; the Gold Pallet.

To Mr. Branston, Wynnyat-street, for an Engraving on Wood of a Scene in the Comedy of Measure for Measure; the smaller Silver Pallet.

To

To Miss Mary Hay, Chandos-street, for a Drawing of the Ecce Homo, Class 100; the Silver Medal, set in Gold.

To Miss Zornlin, Newington-place, Kennington, for a Drawing of Antigone; the greater Silver Pallet.

To Miss Beverley, Spring-gardens, for a Drawing of a Landscape; the smaller Silver Pallet.

To Mr. J. S. Halfpenny, 59, Stafford-place, Pimlico, for a Drawing of the Antinous, Class 105; the greater Silver Pallet.

To Mr. George Corbould, 70, John-street, for a Drawing of an Antique Statue; the smaller Silver Pallet.

To Mr. John Romney, 10, Warren-street, for a Drawing of Outlines, Class 102; the smaller Silver Pallet.

To Miss Andree, Hatton Garden, for a Portrait of a Lady in Oils; the greater Silver Pallet.

To Miss Sarah Benwell, Oxford, for a Drawing of Our Saviour on the Cross; the greater Silver Pallet.

To Miss E. Scott, Saint James's-street, Brighton, for a Drawing of the Virgin and Child; the greater Silver Pallet.

To Miss M. A. Barron, New London-street, Tottenham Court Road, for a Drawing of the Death of Socrates; the smaller Silver Pallet.

To Mr. Richard Neate, Hadley, who is crippled in all his limbs, except his left arm, for a Drawing of the Holy Family; the smaller Silver Pallet.

To Mr. Sebastian Grandi, 6, Brownlow-street, Long Acre, for a Preparation of Grounds or Pannels for Painters; Twenty Guineas.

In Manufactures.

To Mr. J. Robertson, of Edinburgh, for a Method of weaving Fishing-Nets; Twenty Guineas.

To Mr. William Neven, 19, Barrack-court, Woolwich, for weaving extremely fine Cloth; Fifteen Guineas.

In

In Mechanics.

To Dr. Thomas Cogan, Bath, for a Drag to save Persons from being drowned, Class 140; the Gold Medal.

To John Trotter, Esq. Soho-square, for a Curvilinear Saw; the Gold Medal.

To Mr. John Austin, Glasgow, for a Loom, worked by Machinery; the Gold Medal.

To Mr. Neil Snodgrass, Johnstone, county of Renfrew, Scotland, for a Mode of heating Rooms by Steam; the Gold Medal or Forty Guineas.

To Mr. J. Middleton, St. Martin's-lane, for Improvements in printing Paper-Hangings; the Silver Medal.

To Mr. G. Field, Newman-street, for a Stove for heating Rooms, or drying different Articles; the Silver Medal.

To Mr. Benjamin Scott, Bermondsey-street, for a Machine for splitting Sheep Skins; Twenty Guineas.

To Mr. James Hardie, Glasgow, for a Bookbinder's Press; Fifteen Guineas.

To Mr. Jos. Davis, 14, Crescent, Kingsland Road, for a Machine to prevent Accidents to Glaziers or Painters; Ten Guineas.

To Mr. A. Stass, 18, Porter-street, Newport Market, for a Machine to assist in making Shoes; Ten Guineas.

In Colonies and Trade.

To Mr. Philemon Wright, County of York, Lower Canada, for the Culture of Hemp; the Silver Medal.

To Mr. Frederic Arnold, River Thames, Upper Canada, for the Culture of Hemp; the Silver Medal.

To Mr. Joshua Cornwall, River Thames, Upper Canada, for the Culture of Hemp; the Silver Medal.

To Mr. G. Ward, Township of Camden, Upper Canada, for the Culture of Hemp; Twenty Dollars.

List of Patents for Inventions, &c.

(Continued from Vol. VIII. Page 464.)

SAMUEL MILLER of the parish of Saint Pancras, in the county of Middlesex, Engineer; for various improvements in the working of coal, tin, lead and other mines, by which there will be a great saving of fuel and labour, and many accidents prevented. Dated April 1, 1806.

JAMES KEIR, of West Bromwich, in the county of Stafford, Esquire; for an improved method of manufacturing white lead. Dated April 3, 1806.

WILLIAM HENRY LASSALLE, of the city of Bristol, Apothecary; for certain improvements in soap. Dated April 5, 1806.

JAMES KAY, of Preston, in the county of Lancaster, Machine-maker; for improvements upon Thomas Johnson's patent machine for dressing cotton, silk, and other goods by power. Dated April 17, 1806.

THOMAS JAMES PLUCKNETT, of the parish of Christ Church, in the county of Surrey, Agricultural Machine-maker; for a machine for dibbling and drilling all kinds of grain and pulse. Dated April 17, 1806.

ANTHONY FRANCIS BERTE, of the parish of Saint Dunstan in the West, in the City of London, Merchant; for a machine for casting or founding types, letters, and ornaments, usually made use of in printing. Dated April 29, 1806.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. L. SECOND SERIES. July, 1806.

Specification of the Patent granted to DAVID HARDIE, *of the Parish of Saint James, Westminster, in the County of Middlesex, Gentleman; for the Improvement of an Apparatus for Weighing, in a Manner less liable to Error, and with greater Expedition, than by any of the Modes of weighing hitherto used.*

With Engravings.

Dated March 19, 1800.

TO all to whom these presents shall come, &c. Now KNOW YE, that I the said David Hardie, in compliance with the said proviso, do thus particularly describe and ascertain the nature of my said invention, and the manner in which the same is to be performed.

Fig. 1, (Plate IV.) shews the manner of delineating certain scales on the scale-board appropriated for the weights, for the purpose of pointing out, on mere inspection, the total gravity of the weights placed upon these scales by means of mensuration. The larger scale A B shews the total gravity of the weights placed

on it, stated in hundreds and quarters; and the smaller scale C D shews the total gravity of the weights placed on it, stated in pounds. The weights belonging to the larger scale to be the larger kind of weights, consisting of hundred weights and quarter hundred weights. The weights belonging to the smaller scale to be the smaller kind of weights, consisting of a fourteen pound weight, a seven pound weight, a four pound weight, a two pound weight, and a one pound weight. The larger scale to be divided into spaces equal in number with the quarters of hundred weights contained in the whole of the weights required to cover it, and these spaces to be of a like form, and of a size to admit of a quarter hundred weight to stand on it in a firm manner. The smaller scale to be divided into twenty-eight equal spaces, of a like form, and of a size to admit of a pound weight to stand on it in a firm manner, taking care that the weights be so formed as not to require a scale-board much above the size of those now in use. The bottom of each half hundred weight to form a square equal to two spaces of the larger scale, and the bottom of each quarter hundred weight to form a size and shape of one of the spaces of that scale. The bottom of the fourteen pound weight to cover half the length of the smaller scale, that of the seven pound weight one-fourth part, that of the four pound weight one-seventh part, that of the two pound weight one-fourteenth part, and that of the one pound weight one-twenty-eighth part. The sides of all the weights to be perpendicular, and the amount to be stated on the scale, in progressive numbers, close to the places the weights stand on. When any number of the larger weights are placed in close succession on the larger scale at the beginning thereof, and in the direction from A to B, each taking up its due space, the numbers visible

next

next to the last weight are the total gravity of these weights stated in hundreds and quarters, the first number being the hundreds and the second number quarters; and when any number of the smaller weights are placed in close succession on the smaller scale at the beginning thereof, and in the direction of C to D, each occupying its due space, the number visible next to the last weight is the total gravity of these weights stated in pounds. For instance, if five half hundred weights, a quarter hundred weight, a fourteen pound weight, a seven pound weight, and a one pound weight, be thus placed on their proper scales, the total gravity will appear on mere inspection to be two hundred weight three quarters of a hundred weight and twenty-two pounds; the hundreds and quarters being seen on the larger scale, and the pounds on the smaller scale. On the same principle the scale or scales on the scale-board appropriated for the weights might be constructed various other ways. The remaining figures shew certain apparatus, to prevent the necessity of removing the greater number of weights from the scale-board on each operation, varied to suit the different situations for weighing the different quantities weighed at each operation, and the different sizes of the goods.

Fig. 2, an elevation of the scale-board for the weights when fixed to the ground by means of a bolt placed a little below the level of the floor, and running through a staple in the centre of the bottom of the scale-board. A, the staple of the scale-board. B, the bolt to be pushed backwards and forwards by the lever C by means of a rack at the end of the bolt, and corresponding teeth at the end of the lever. D, a staple to guide the bolt, and resist its pressure upwards.

Fig. 3, a perspective view of the apparatus without the scale-board.

Fig. 4, the scale-board for the goods when fixed to the ground by two united claws placed a little below the level of the floor, and holding two projecting pieces attached to two of the sides of the board. A A, the two projecting pieces. B B, the two united claws. C C, staples in which the claws turn to open and shut. D, staple and pin to assist the other staples to prevent the pressure upwards.

Fig. 5, the scale-board for the goods, with the two projecting pieces.

Fig. 6, the united claws, with their staples and pin.

Fig. 7, an apparatus fixed to the ceiling. When the weight E, suspended by a rope passing over the pullies CC, is raised up to the bolt A, by its own weight drops on the arm of the beam, which supports the goods; the click B catching one of the ratchet teeth at the upper end of the bolt, prevents the bolt from being forced upwards, and the claw at the lower end prevents the arm escaping at either side. On pulling the rope F that passes over the pullies D D the click is disengaged, and the weight E raises the bolt.

Fig. 8, section of the principal parts of an apparatus to support the scale-board and weights, and to raise them still higher, should occasion require. The pinion C, turned by the raising apparatus of my patent crane *, a lever, or a winch, acting on the rack B, raises the board A to receive the scale-board and weights, and to support them, or raise them higher. A ratchet wheel and click prevents the board A from dropping down by the pressure of the scale-board and weights.

Fig. 9, an apparatus for raising and lowering the whole beam with scale-boards, goods, and weights, or for supporting or raising the scale-board with the weights

* The specification of this patent will be inserted in a following number.

only.

only. A, a lever, which admits of being lengthened occasionally by drawing out of it the piece B. C, a rope to move the lever. D, a catch to keep down the lever. E, a rope over the pullies F F to disengage the catch.

Fig. 10, section of the like apparatus with Fig. 9, assisted with a wheel and pinion. By pulling the rope D attached to and coiling round the circumference of the wheel C, the pinion B turns round, and acts on the teeth at the end of the lever A. The lever is kept stationary by the ratchet wheel E and click F, which is disengaged by the rope H passing over the pulley G.

In witness whereof, &c.

OBSERVATIONS BY THE PATENTEE.

The scales which determine the total weight on the board, as well as the shape of the weights, being modified according to the various cases to which they are applied, I refer to the two following examples, in addition to the one adduced in the specification, *viz.*

First Example.

Fig. 1. Plan of a board for the weights, about thirty-eight inches by thirty-two inches, capable of weighing a ton; on which are delineated two scales, one of larger divisions for the half hundred weights, and the other of smaller divisions for the pound weights.

Fig. 12. Plan of a half hundred weight of cast-iron. A, an excavation, forming the handle without projecting.

Fig. 13. Elevation of a half hundred weight. A, an excavation, forming the handle, with B, a hole for lead to adjust it.

Figs. 14 and 15. Plans of two half hundred weights, shewing the manner they are placed to fill a square allotted for the amount of a hundred weight.

Fig.

Fig. 16. End elevation of the pound weights of brass, fitted to the scale of an inch to a pound, the part scooped out at the sides, being to receive the points of the fingers and thumb to lift them without handles.

The larger weights are placed on their particular scale, beginning at A on the left, and proceeding to the right, and so on with each row. The first hundred weight covers the blank square, the second the square marked 1, the third that marked 2, and so on.

The pound weights are placed on their particular scale, beginning at B on the left, and proceeding to the right.

There is no scale for the quarter weights, being at most only two in number, namely, a half hundred weight and a quarter hundred weight, of which the total is evident on inspection. The totals of the hundreds and pounds are indicated by the numbers next to the weights, respectively on the right hand. Hence it follows, that the amounts of the weights on the board in hundreds, quarters, and pounds, are accurately known to the weighers by mere inspection; and that the book-keeper has it in his power, with a glance, to discover whether the weighers call the proper weight. The greatest individual weight, for the purpose of being portable, is a half hundred weight. When a very light package is to be weighed with a board adapted for a much greater weight: a hook and eye are to be used at each of the two cords, suspending the board for the weights at A and C, in order to shorten them, and prevent the board from leaning to one side. Where a chain instead of a rope is used, one of its links might serve as an eye to the hook.

Second

Second Example.

Being a board with vertical scales, shewing the total weight in pounds.

Fig. 17. Plan of a board, with A a vertical scale, for the larger weights, of a thickness after the rate of one inch for every ten pounds; and B a vertical scale for the smaller weights, which are one pound each, and one inch in thickness.

Fig. 18. Elevation of the board and scales.

Fig. 19. Plan of the larger weights.

Fig. 20. Plan of the smaller weights, each weight having a hole through the centre, to admit the scale.

In consequence of exhibiting the amount of the weights on the board, by means of a scale, with mathematical precision, the patent weighing apparatus obviates the numerous errors of the common mode of weighing arising in the process of counting the larger weights, and adding the sums of the smaller weights to determine that amount; and at the same time performs the operations with much greater dispatch, as may appear from the following particulars.

With respect to the number of the smaller weights, the common mode is subject to a choice of evils. If they were more numerous they would require more time in finding the amount, and also be more liable to error in the addition; but by being only five in number, namely, a one pound weight, a two pound weight, a four pound weight, a seven pound weight, and a fourteen pound weight, they occasion a waste of time in producing the quantity required. For instance, if a one pound weight, a two pound weight, and a four pound weight were laid on the board, and should prove one pound short of the weight, this additional pound could only be obtained by the complicated mode of placing on the board a seven

pound

pound weight, and removing the two pound weight and the four pound weight, whereas the patent apparatus, by admitting into use a multiplicity of the smaller weights without being liable to error, could in such case produce the proper weight in less time by the simple operation of placing an additional pound weight on the board, while the waste of time arising from the extraordinary agitation of the beam occasioned by placing a seven pound weight on the board, and removing the two pound weight and the four pound weight, would be prevented. A still farther loss of time is incurred through the operation of counting the larger, and adding the sums of the smaller weights, which is an evil entirely obviated by the scales of the patent weighing-apparatus, shewing the total weight on mere inspection.

Specification of the Patent granted to MALCOLM COWAN, *Commander in his Majesty's Royal Navy; for Improvements in the Construction of Sails for Ships and Vessels of all Descriptions.* Dated June 11, 1805.

With Engravings.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Malcolm Cowan do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, by the plans or drawings in the margin of these presents; that is to say: The sails are to be made of canvass, or any other proper substance, article, or material, with the cloths or seams horizontal, with a reef or reefs at the foot according to the use they are intended for, and are to be so constructed, as to reef or reduce at the foot or lower parts, as well as at the head or upper parts, and to have as many reefs as may

be thought necessary. The reefs are to be made or without bands at the fore or afterpart of the sails, ef or reduce and set again by means of the bands, et-holes, ropes, lines, points, robins, gaskets, blocks, bles, cringles, and hanks, all, or as many of which ıay be required, according to the dimensions of the and other circumstances. The bands to be either :d or not as may be found necessary.

Explanation of the Drawings.

The courses and top-gallant-sails to be reefed from the deck, and the top-sails by one man or more at each lower yard arm. A, Fig. 21, (Plate IV.) the after part of the sails. B, a strong band on the after or fore part of the sails, sewed on at the upper part only, and roped at the lower parts. C, the long clews of the course formed by the bight of the leech rope, and rope of the reef band, with thimbles seized in above the tack blocks for lashing the lower clews to. D, the tacks and sheets fitted to the upper clews of the courses with thimbles above the tacks blocks. E, The buntlines brought up through the thimbles H, on the foot ropes of the sails and bent to the cringles I, on the ropes of the reef bands. F, small ropes or gaskets rove occasionally as a reef line in separate pieces through eyelet-holes under the reef bands, and made fast to the middle or quarters of the sail for confining the slack sail when reefed, in the wake of the reef bands and quarters. G, thimbles in the clews, earings, and leeches. K, thimbles on the foot rope with earings rove through them. L, the reef tackle pendants passing through thimbles in the clews of the top sail, and brought up and bent to the cringles above the upper reef band. M, a boom tackle or burton hooked to the reef pendants. N, the crowfoot legs to the top-gallant buntline, for keeping the slack sail up clear of the stay.

N. B. The reef bands are sewed by the upper part to the after part of the sails, to prevent the rope from girting the sail when the whole sail is set. The rope of the reef band of the course is the same size as the common foot rope, and the foot ropes must be in proportion to the rate of the ship: for first rates, three three-quarters or four inch; second rates, three and an half; third rates, three inch rope, as the quantity of sail below the reef band does not require so strong a foot rope as when the whole sail depended on it. The rope of the reef bands of the top-sails should be smaller than the leech ropes, as the foot of the sail will be considerably strengthened when reefed. These sails are not so heavy as the common ones. A seventy-four gun ship's course is reduced in weight about two hundred pounds, as the points, bands, and eyelet-holes of the old reefs are not required, nor any additional geer. Men of war will find one reef at the foot of the top-sails very useful in chace, in squally weather, or when obliged to haul suddenly on a wind or on other occasions; merchants' ships will only require two reefs in the top-sails, as the squarest part of the sail is taken off by reefing at the foot instead of the head, but more reefs may be added if necessary. When the courses are to be reefed, cast off the lower clews from the thimbles in the upper clews, haul up the slack sail by the buntlines, and haul tort the reef line one part at the time from the middle of the sail towards the clews, and make it fast round the upper clews, so as to confine the lower clews; to set the sail, reeve a few turns of the lashing for the clews, and haul them down, over-hauling the reef line and buntlines; to reef the top-sails, send a man up to each lower yard arm, settle the hallyards, and haul the sail down by the reef tackles, and pass the turns of the earings through the thimbles in the earing cringles and on the foot rope, and make them fast; hoist the sail tort up, haul through the slack

slack of the buntlines, and haul tort the reef line on each side towards the clews and make fast; the top-gallant sails are reefed from the deck by the clew lines and a single buntline with a crowfoot; the buntlines and reef lines will confine the slack sail when reefed close up in the wake of the reef band, and the buntlines will only require to be kept hand tort as is usual to prevent them from chafing the sail.

Advantages proposed.

To enable ships to reef their courses in a few minutes when on a lee shore in stormy weather, when it may be necessary to reduce the sails, at the same time dangerous to take their effect off the ship by hauling them up, to reef them on the yard; or, when the ships' crews are reduced by sickness, by part of them being in prizes, or employed on shore, or weakened by labour or fatigue; in gales of wind in frosty weather when it is difficult to handle the sail; in merchants' ships with few seamen, and partly manned with invalids, Lascars, Indians, or negroes, &c. &c. The sails can be hauled up and set again in less time, as one part of the sail is taken off or set again at a time, and consequently receives less of the force of the wind. When ships are obliged to carry a press of sail in squally weather, in chace or other occasions, the sails may be reefed and set again in a minute, without starting tack or sheet, or risque of splitting; if a sail should split in one part, it would be stopped by the reef bands. When the sail is hauled up, it will be almost furled to the yard, from the buntline being brought abaft the sail, and bent to the cringles on the rope of the reef band. The weight of the reefs is removed from the yard to the foot of the sail, without encreasing the strain on the yards. The sails being reduced at the foot instead of the head will stand longer and better in a gale of wind, as the squarest part of the sail is taker off when reefed.

When carrying sail in action, these sails can be hauled up at the lower part out of the way of the fire from the guns, or in fishing the anchor, as the fore sail is very often in the way, particularly to leeward. The expense of these sails will be less, and they will last longer from not being so liable to split in hauling up or setting; half worn sails are worth altering, as there will be a considerable saving in the wear and tear of the sails. Ships with these sails will make quicker voyages from the safety with which they can carry sail by day or night, and in many situations would be in perfect safety, when ships with the old sails might be utterly lost.

Observations.

The sails made on this plan are applicable to ships and vessels of every description, and may in many situations that ships are liable to be in, be the means of saving them from destruction, particularly in the winter season, when so many ships are unavoidably exposed in gales of wind to the dangers of lee shores and narrow seas.

N. B. One principal object of my invention is, the application of a reef or reefs at the bottom of the sails, which has not been heretofore; but the same may either be used alone, or in conjunction with a reef or reefs at the top of the sails, as at present in use. Another object of my invention is, to have the cloths of which the sails are made, and seams or joinings, horizontal instead of vertical; but my improvement in reefing is equally applicable to sails, the cloths and seams of which are vertical. Another improvement is shewn in sail marked O in the said drawings, which may be applied to ships and vessels of all descriptions using fore-and-aft sails, and may serve occasionally for awnings, and facilitate the management of brigs, ketches, schooners, sloops, and cutters, in blowing or bad weather. In witness whereof, &c.

Specification

Specification of the Patent granted to JOHN TROTTER, *of Soho-square, in the County of Middlesex, Esquire; for a Rotary Engine, for applying the Powers of Fluids as First Movers, and for various other Purposes.*

With an Engraving.

Dated November 14, 1805.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Trotter do hereby declare, that my said invention, and the manner in which the same is to be carried into effect and practice, are described in manner following; that is to say: my rotary engine consists of the following parts put together in a workman-like manner, or one or more of the same may constitute one piece in the casting, fashioning, or making; where circumstances or convenience may admit of such fabrication.

1st, A, Fig. 22, (Plate IV.) a circular piece called the outer barrel.

2dly, B, a circular piece called the inner barrel.

3dly, C, a circular piece called the eccentric.

4thly, D, a piece called the sweep, which shuts completely across the space between the inner and outer barrels, so as to intercept the communication in that part.

5thly, caps or covers at each end of the said pieces, which close the space between the two barrels, and serve by grooves or other well-known fittings, to keep the other parts in their respective places.

The situations and motions of the parts herein enumerated, are as follow: 1. The barrels are concentric. 2. The sweep is capable of moving or revolving (either by absolute or rotative motion) through the space between the barrels: it may be either separate from the barrels, or it may

may be fixed to either or both of them, and in the last-mentioned cases, the barrel or barrels to which the sweep shall or may be so fixed will necessarily move along with it. The sweep is so well fitted or fixed, that no fluid shall pass through the places of its apposition or junction with the barrels and caps, or as that the quantity suffered to pass shall be inconsiderable. 3. The eccentric is of such a diameter and so wrought, that its concave and convex surfaces shall touch the inner and outer barrels, and that the places of contact shall not admit any fluid to pass between the eccentric and each barrel severally, or at least that the quantity which may so pass shall be inconsiderable. The eccentric is capable of rotation in its own plane or periphery, but not otherwise with relation to the caps; and it has a long perforation through which the sweep is put, consequently the sweep and the eccentric will always move together.

The Operation or Effect explained.

It may be pointed out, as distinguishing characters of my said engine, that whenever the sweep is moved, the space which is comprehended between the barrels and the eccentric, and the posterior or hinder surface of the sweep, will be continually enlarged, and that the space which is in like manner comprehended between the barrels and the eccentric, and the anterior or fore surface of the sweep, will be continually diminished, excepting that soon after the sweep has passed at or near the places of contact between the eccentric and the outer barrels, the posterior space will be suddenly diminished by the separation of all that portion thereof, which was comprehended between the eccentric and the outer barrel, in consequence or by reason of the said place of contact having come to be behind the sweep. And also, that

soon

soon after the sweep has passed at or near the place of contact between the eccentric and the inner barrel, the posterior space will be suddenly diminished by the separation of all that portion thereof which was comprehended between the eccentric and the inner barrel, in consequence or by reason of the said place of contact having come to be behind the sweep; and the said portions so separated will in each case respectively become portions of the anterior spaces, in consequence or by reason of the interval or distance which will at the same time be formed or made between the eccentric and the barrel immediately before the sweep. Whence it is manifest, that if any fluid be forced by gravity, elasticity or otherwise, through one or more apertures from without into the space on one side of the sweep, that pressure will carry the sweep forward and the eccentric along with it, together with such barrel or barrels as by the construction as aforesaid shall or may be fixed to the sweep; and moreover, if there be any one or more other apertures communicating from the opposite side of the sweep, in order to allow the said fluid to escape, or be carried off, or condensed, or otherwise disposed of, all such portions of the said fluid as by the changes of situation of the sweep hereinbefore described, shall be separated from occupying part of the space behind the sweep, and shall come to occupy part of the space before the same, will in fact so escape, or be carried off, or condensed, or disposed of, and the rotary motion of the engine will be kept up, and may be applied as a first mover to other works, so long as a due supply of the said fluid shall be afforded.

And it is farther manifest, that in case the rotary motion of the said engine be produced by any force not applied to its internal parts in the manner hereinbefore described, and any fluid be admitted to communicate with the

the posterior space within the same, the said fluid so admitted will flow into or be absorbed in the said space which becomes continually enlarged, and will afterwards be transferred to and drawn out of the anterior space which becomes continually diminished as aforesaid; and that, in this application, the said engine may be used to raise or give motion to fluids in any direction whatever. And I do hereby declare, that my said engine is to be constructed or made with such apertures, by me called passages, for the introduction and admission, and for the subsequent escape, carrying off, condensing, disposing of, or driving out such fluid or fluids, as shall or may be introduced therein; and that I do so introduce, for the purposes and uses aforesaid, various fluids severally, such as water or other dense fluids, air or steam, or vapours, or other rare and elastic fluids, all or any of which may be produced or extricated by heat or otherwise.

And farther, that the said passages may be opened or made in various parts of the said engine, as will be sufficiently obvious to any person skilled in the construction of works of the like nature; but that I prefer making the said passages in one or both of the barrels as near the sweep as conveniently may be, so that one or more passages shall be on one side of the sweep, and the other passage or passages on the other side thereof; and in these cases it will be requisite that the sweep should be fixed to the one or both barrels, in which such passages may be or shall be so made.

And I do farther declare, that my said engine is intended to be connected with other works, in order to drive the same as a first mover, by the well-known means of connecting first movers, so as to carry on the various processes and operations of mills, manufactories, the propelling of vessels, and performing various kinds of mechanical

Fig. 1.

C				A
1				
2				
3	6.1	4.1	2.1	0.1
4				
5				
6	6.2	4.2	2.2	0.2
7				
8				
9	6.3	4.3	2.3	0.3
10				
11				
12	7.0	5.0	3.0	1.0
13				
14				
15	7.1	5.1	3.1	1.1
16				
17				
18	7.2	5.2	3.2	1.2
19				
20				
21	7.3	5.3	3.3	1.3
22				
D	8.0	6.0	4.0	2.0	B

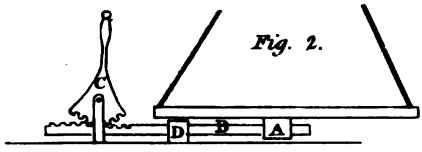


Fig. 2.

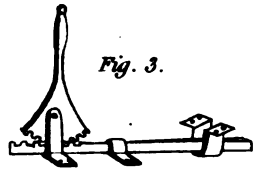


Fig. 3.

Fig. 4.

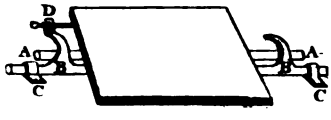


Fig. 5.

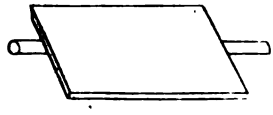
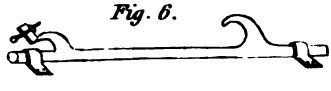
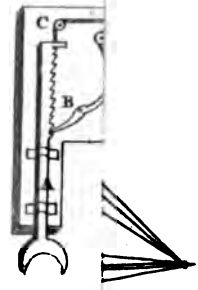


Fig. 6.





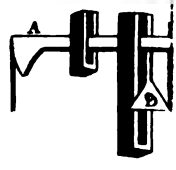
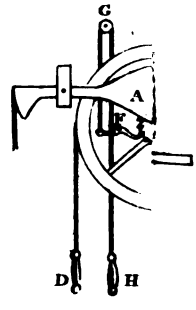


Fig. 10.



mechanical work on-board the same; the deepening of harbours, giving motion to carriages, and of producing other effects, which, on account of their extent, magnitude, number, and evident practicability, do not require to be enumerated.

And farther, that in the case wherein my said engine is employed to raise or give motion to any fluid introduced therein, the effects produced will be of the same description as those of sucking, lifting, or forcing pumps, fire-engines, forge and furnace bellows, ventilators, winnowing fans, and such other engines as operate by giving motion to fluids.

And, with regard to the said circular barrels and eccentric, that I give the preference to the cylindrical form, but that the cylindrical form is not absolutely necessary, inasmuch as the said parts may have the form of frustrums of cones, or other figures described by rotation. And the said figures, with the dimensions thereof, are sufficiently indicated by the description and effects herein before given and pointed out.

And, lastly, with regard to materials and fitting; that the materials must be taken according to the intended uses, and the judgment of the engineer, who may use metal, wood, paper, leather, glass, pottery, or any other fit substance. The fittings must in general be good, and the work true: and it scarcely needs be remarked, that steam requires closer fitting (or packing if needful) than water, and water requires closer fitting than air for blowing or fanning where the pressures are not considerable, and motion rapid. And that when convenience in other respects may make it desirable, a degree of windage may be allowed between the moving parts respectively.

In witness whereof, &c.

Specification of the Patent granted to MARTIN CAWOOD, *of Leeds, in the County of York, Brass and Iron Founder; for an Improvement in the manufacturing of Metallic Cocks for conveying and stopping of Liquids.*

Dated May 15, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Martin Cawood do hereby declare, that my said invention is described in manner following; that is to say: Instead of casting the cocks of brass, which has hitherto been the practice, I cast them of iron, and face, plate, bush, or cover with brass or bell metal, or such like metal, or composition of metals, those parts of the piston and cylinder which come in contact with each other when the cock is in use. This facing, plating, bushing, or covering, to be fastened on by cementing, tinning, soldering, or brazing, and the piston and cylinder are fitted with each other in the usual way.

In witness whereof, &c.

OBSERVATIONS BY THE PATENTEE.

The common composition for brass cocks, which is made of copper and lead, is found by experience not adapted to bear the extremes of heated steam and a cold or frosty atmosphere. The copper being saturated with a large proportion of lead, its properties are made tender, and easily susceptible of expansion and contraction by heat and cold, which causes the cocks frequently to burst. The lead also makes the metal cloggy, and by a very small heat will strike to the surface; consequently a great

a great deal of friction is produced, which very often so fastens the cock that it cannot be turned, or takes away the smoothness which ought to remain in the piston and cylinder, and then the cock is useless, not being air-tight. Cocks, plated as above specified, are not liable to these objections, as it is universally allowed by all engineers, that good soft iron is found to stand better than any other metal the extremes of heat and cold; hence steam cylinders and hot water pumps for engines are now made wholly of that metal. The metal also with which the piston and cylinder of these cocks are plated, being of small weight, the patentee can afford to make it of such superior quality, that the objections made against common cock-metal cannot apply to his mixture, which is made of bell-metal, wherein no lead is used. Common cocks when out of repair are in general sold as old metal; for when they are ground two or three times, the hole in the piston is so low in the cylinder that it will not admit a sufficient quantity of fluid equal to the bore of the cock, but in these plated cocks, when the piston is worn too low (which will rarely be the case, owing to the superior quality and hardness of the metal which comes in contact when in use) the piston or cylinder can be plated at a trifling expense, and the cocks rendered as good as new: this in large cocks, for which this invention is more especially adapted, will be a very great saving.

N. B. Cocks of all calibres, from one-fourth of an inch upwards, made to fix on all kinds of iron, copper, or lead pipes, with flanges or tinned tails, at half the price of the common brass cocks of equal bore, may be had at the manufactory in Leeds.

On the Nature and Properties of Manures, and the Mode of preparing and applying them to various Soils. By ARTHUR YOUNG, *Esq. F. R. S.*

(Continued from Page 37.)

CHAPTER III.

Of Lime.

AFTER the volumes which have been written upon this manure, it ought to have been well understood in every variation, and in every application; but so much theory has been mixed with facts, that the contradictions are numerous and perplexing. The only chance of attaining plain and simple truths will be, to reject all opinions, and examine the language of experiment alone.

§ 1.—*The Nature of Lime.*

All hard calcareous substances, of whatever colours or other quality, will burn into lime: marbles of various sorts, limestone, chalk, spar, &c. The operation of fire expels from these substances certain portions of water and carbonic acid, leaving pure, or nearly pure, calcareous earth: which, while deprived of its acid, has certain caustic and other qualities. It has a strong power of re-absorbing moisture and carbonic acid when exposed to the atmosphere, and from all other bodies with which it comes in contact; but it cannot unite with the air unless it is previously moistened: 100 parts of lime absorb about 28 of water. To regain its full portion of air from the atmosphere, it requires a year or more; but not if spread purposely *. One thousand bushels *per* acre have been spread in Derbyshire. In the proportion of twenty cwt. of lime gaining five cwt. from the atmosphere, that

* Kirwan,

quantity

quantity would gain above thirty tons from it *. Of how great consequence is it to discover the effect of carbonic acid on vegetation?

Relative to the other constituent parts of lime, there is yet in the chemical world some uncertainty. Mr. Boyle says expressively, that he has found sulphureous particles in lime. There is no doubt of iron being contained in many lime-stones. Dr. Priestley conjectures, that some of (what he calls) the phlogiston of the fuel adheres to the lime. Lavoisier declares, that quick-lime contains a great quantity of the matter of pure fire. He notes also some slight traces of volatile alkali, if burnt in a close vessel. It is soluble in about 700 parts of water. The observation of Guyton de Morveau, that lime is composed of carbon, nitrogen, and hydrogen, is not sufficiently cleared up; it contains phosphorus †.

These remarks are applicable to the purer limes; others less pure contain a portion of calcined sand and clay. But whatever is peculiar to lime depends on the calcareous earth. There is one material variation in the nature of lime, which arises from the stone having a mixture of magnesia in it. Mr. Tennant has explained this fully in the Philosophical Transactions, by comparing the lime-stone of Doncaster with that of Ferrybridge: the latter is very pure; and the former contains three parts of pure calcareous earth, and two parts of magnesia. Bredon lime in Derbyshire is of the same quality. Magnesian lime-stone is easily known by the slowness with which it dissolves in acids; the colour is also a means, if not absolutely of detecting, at least of suspecting its presence, for no lime-stone that breaks blue contains it; the hue is generally brown, or of a fawn-colour. It has been found

* Bishop Watson. † Darwin.

from

from many observations to be mischievous in agriculture, as calcined magnesia is a poison to plants.

§ 2.—*The Properties of Lime.*

These are evident to any person who considers the constituent parts. By its calcareous earth in a mild state, that is, when all or much of its carbonic acid is re-absorbed, it has all the properties of chalk or marle, so far as the calcareous quality is concerned; it yields that substance to plants, if wanted; it neutralizes acid salts, and consequently will act powerfully on all peat soils, whether bogs, fens, or moors: but it will not give tenacity to sand-like marle, nor the friability to clay which chalk will effect. When laid on in its caustic state, and especially in large quantities, it destroys the spontaneous growth of those and such like soils; for, though it resists putrefaction, (which is no good quality,) yet it resolves organic substances into a mucus *. The truth of this observation is visible on limed moors; and this is a very valuable quality, when the spontaneous growth is a nuisance, as it generally is on those soils. It strongly attracts inflammable substances, such as sulphur and resins †; and Dr. Darwin ingeniously supposes, that by its union with carbon it renders that substance soluble in water, forming a *hepar carbonis*. But circumstances which demand reiterated experiments, and are in truth extremely curious, can be no more than hinted at. It is in a state, when slacked, of such extraordinary divisibility, that it is capable of much more intimate combination with other substances than either marle or chalk.

In proportion as the carbonic acid is beneficial to vegetation, must be in a great measure the importance of lime. But here some obscurity attends the subject; for

* Kirwan. † Delaval.

neither

neither in this respect, nor with any view to its phosphorus, fire, volatile alkali, or any other secondary constituent part, is it to be considered as *directly* yielding the food of plants. A thousand practical observations prove, that upon very poor soils it has no effect; and that the benefit derived from it is in proportion to the undecomposed vegetables in the land.

§ 3.—*Collecting; Preparation.*

Lime-stone exists in many districts unknown to the farmer: in this respect it varies from chalk. In the south-eastern counties of the kingdom, the basis of which is chalk, a farmer may be almost sure that chalk is under him, though perhaps at a depth unprofitable to work; but lime-stone is more various, and found in more insulated situations. The common test is by pouring a powerful acid on the stone; yet this test is not practically correct; for some specimens which effervesced with nitric and muriatic acids would not burn to lime with any heat that could be applied: the cause seemed to be a great mixture of micacious particles.

Calcination is the preparation of lime; an operation pretty well known, wherever it is commonly found. Kilns are of various constructions, and of very different degrees of merit. To describe them would swell these papers to too great a bulk: the most profitable are the perpetual draw-kilns, egg-shaped, with a short neck, and a roof over the mouth in the shape of an extinguisher, open at the point; this gives a draft. Effective burning is a point of much consequence; as the causticity of the lime depends on the entire expulsion of the carbonic acid, known instantly by its levity in the hand. It is burnt with wood in various kilns; and with peat, culm, or small-coal, in draw-kilns.

§ 4.

§ 4.—*State; Application.*

The most material distinction in the application of lime is, that of spreading it fresh in its most caustic state; or keeping it till slacked, and till it has re-absorbed more or less of its carbonic acid. The common practice of various districts has ascertained this point very satisfactorily, and in perfect conformity with chemical principles.

Upon all soils in a state of nature, and greatly abounding with undecayed vegetables, which are required to be speedily destroyed, it should be and is spread *hot from the kiln*, as it is termed, which is in its most caustic state. But in other cases, by the general practice, and consistently with principles, lime is slacked before it is spread. Upon waste lands the causticity has an evident and necessary effect; but not upon cultivated soils, where the antiseptic quality of the substance, while deprived of its carbonic acid, would tend to prejudice rather than improvement. When the lime has regained its gas, it rather promotes putrefaction; and if carbonic acid be really *a food of plants*, the acquisition of so large a quantity in the soil cannot be immaterial.

A truly practical husbandman of great experience gives directions for the application which merit attention. "Let the whole quantity of lime intended to be used on any given field of moderate size be laid into one heap, where water can be had most conveniently. Let it be there thoroughly slackened; and immediately after it is cold, which it will be in a day or two, fill the carts, and spread the lime out of them with shovels equally over the surface. The more common method of laying it down in small heaps over the whole field, to slack by rain, is very erroneous: it is liable to get too much rain, which, in place of reducing it into a fine powder, converts

verts it into a running mortar, in which state it will neither spread equally, nor mix with the soil *." And Mr. Wight remarks, for the same reason, that both the soil and the lime should be quite dry at the time of spreading. In Dumfriesshire, quick-lime being compared with that which had lain in a heap for several years, in consequence of a law-suit, the latter did much more good than the former †.

§ 5.—*Season.*

Where improvements are carrying on upon a large scale, and draw-kilns are kept at work through the year, the choice of season becomes of secondary importance; but liming should otherwise no more go on in winter than building. It may be continued from March to October; but summer is the best season. It should be spread on a layer one full year before ploughing, that it may have time, as Mr. Craike observes, to fix itself firmly on the sward. If ploughed too soon, it falls to the bottom of the furrow, and will be the sooner lost; for it continually sinks. The same observation has been made in Perthshire; they do not plough till it has taken a firm *gripe* of the ground ‡. The same was the result in Lancashire. Three years before breaking up a ley, part was limed with three hundred bushels an acre; and another part, only one year before; the former produced oats 10 for 1 of the seed, the latter 6 for 1 §.

* Mr. Craike, of Arbigland. Trans. Dumf. Soc. No. II. p. 84.

† Report,

‡ Statistical Account of Scotland, vol. XIX. p. 486.

§ Dr. Campbell's Communication to the Board of Agriculture.

§ 6.—*Quantity.*

It would be easy to collect many authorities, and even respectable ones, which specify the quantities that have been used successfully; but the advantage would not be considerable, unless there was a clear reference to other circumstances. In the practice of the greatest and most able cultivators, soils are rarely analized carefully by a chemical operation; and without this our information can only be had by halves. The want of chemical examination going hand in hand with farming practice has left agriculture, as a science, but in its infancy. The largest quantities that have been spread, and with entire propriety, have been on bogs and peat moors, and on mountains. The Bishop of Landaff speaks of one thousand bushels *per* acre on moors in Derbyshire with great success; five or six hundred are there not uncommon. Lord Chief Baron Foster, in Ireland, went as far as to three hundred barrels on a moory waste, and found the greater the quantity the greater the improvement. Dr. Anderson tried from one hundred to seven hundred bushels *per* acre, and found the good effect to increase regularly with the quantity. In more common cases, the quantities vary in general practice from thirty-six to one hundred and sixty bushels.

§ 7.—*Soil.*

Upon peat bogs and peat moors and mountains, the subject is discussed as soon as named. Experiments on every scale, and under a very great variety of circumstances, speak an uniform language: the benefit of applying lime is great and decided. On these it operates by means of all its most essential qualities. Its causticity destroys a great spontaneous growth, and converts it into a mucus,

a mucus, which the atmosphere turns into vegetable mould. Upon liming Kedgley-moor, in Northumberland, covered with ling, the ling was killed; and three tons an acre of white clover were mown without sowing any *. The ling flourished in the sulphuric acid, which preserved the seeds of vegetables embedded in an antiseptic mass; but this (when neutralized into gypsum) assisted putrefaction †, and prepared the destroyed vegetables to give nourishment to the dormant seeds.

Next to peat soils, other wastes that are in a state of nature are those on which time has the greatest effect. Part of Meridan-heath was fallowed for a year, and ten acres trebly folded with one thousand sheep, ten acres well dressed with good rotten dung, and ten acres well limed; and all sown with oats and seeds. The part folded had not a bag of oats an acre, and the seeds not worth saving: that which was dunged succeeded very little better: that which was limed produced a most excellent crop of oats and seeds ‡.

On many soils, the circumstance of being full of unconsumed vegetable particles is alone sufficient to ensure great benefit from lime. "In Glendale-ward, Northumberland, the soil is naturally dry, duffy, light, full of fibrous roots, and when in fallow on passing over it you sink to the ankles. After being sufficiently limed the fibrous roots disappear, the soil becomes denser, firm to tread, retentive of moisture, and produces better and

* Sir Digby Legard.

† Mr. Kirwan expressly says, that gypsum has a septic quality; but I am aware of Mr. Davy's experiments to the contrary. As the fact depends entirely on the quantity used, I conceive that repeated trials are necessary to determine the question. A *little* salt assists putrefaction, *much* resists it.

‡ Warwick Report.

more abundant crops of grain: laid to grass, white clover appears to an inch where lime was spread *." And in another case, in the same county, the soil light, dry, and *chanelly*, but *clear from broom*, the effect was equally great. In such instances, to destroy the roots is to consolidate the land. Even on a burning sand, four chaldrons *per* acre have had a striking effect, but it was covered with a mossy sward †. On other soils accounts are various, but many are reconcileable to each other; and probably all would be so if every circumstance had been reported. It does "worst of all on a cold hungry clay ‡." On strong deep clay, extremely retentive of moisture, no perceptible good was produced in eight years §; but on the "rich, loose, friable," puffy clays of Aberdeenshire, the want of lime is the want of wheat ‖. It is obvious to every reader how such accounts harmonize. There would be little use in quoting the many cases in which lime has failed. It cannot succeed where it has nothing to *work upon*, in the farmer's language; it cannot succeed where water deprives it of its most material properties; it cannot succeed where frequent repetitions have given a full dose, perhaps too much of calcareous earth, and consumed every vegetable particle. Proper limeing we have just found to consolidate a loose soil; "too much renders it soft and fuzzy, so that wheat looses at its root ¶." In such cases the author's advice is to roll well after a frost.

I applied lime in various quantities with the ashes of a deep paring and burning. The crops were great, but not the smallest benefit from the lime. No wonder; the

* Northumberland Report.
† Marshall's York.
‡ Blithe.
§ Wight.
‖ Report.
¶ Jenkinson.

fire

fire had converted the vegetable particles to ashes, that is, to carbon, alkaline, and other salts, and calcined earth.

Much might be added to this chapter, on the repetition of limeing, which in Yorkshire *, Wiltshire †, Sussex, &c. has been found useless or pernicious; and also on the courses of crops after such manures. But brevity is necessary in a memoir, which of course embraces so many subjects.

Lime-Stone.

Not to multiply chapters and sections needlessly, I shall here add, that powdered lime-stone has been tried, and found to have excellent effect on such soils as other calcareous manures operate on successfully. Lord Kaimes says, that it is an excellent manure. Du Hamel found it so in France. Dr. Anderson calls it "most beneficial;" and says, that he has seen the model of a mill for pounding it. In North America a red crumbling lime-stone is found to be an excellent manure ‡, and pulverized stone had there great effects §. The rotten lime-stone of the county of Cork ‖ is probably of the same nature as that of America. The immense benefit of lime-stone gravel in Ireland is known to every body: it has been used with great success in Aberdeenshire ¶. I am in doubt whether it is not the best of all manures for improving a bog, its great weight giving the pressure so much wanted on peat-moss.

* Young. † Davis.
‡ Kalm. § Livingstone.
‖ Young. ¶ Statistical Account of Scotland.

CHAPTER

§ 1.—*The Nature of the Ashes resulting from this Operation.*

We shall examine the result of burning.

1st. Vegetables.

2d. Earths, including,
1. Clay,
2. Loam,
3. Sand,
4. Chalk.
5. Peat.

Under one of which heads every soil may be arranged.

These two articles will include all that generally comes within the sphere of paring and burning; for the animal substances in this case are too inconsiderable to demand attention, although the destruction of *living* animals, as worms and insects, is a main benefit of the work.

Paring and burning, says Mr. Kirwan, reduces the roots of vegetables to coal and ashes, and thus prepares both a stimulant and nutriment for plants.

Lord Dundonald observes, that "it is only from the ashes of fresh or growing vegetables that saline substances, or alkaline salts, are to be obtained; none can be got from peat or decayed vegetable matter. The saline matter produced in the process consists of vitriolated tartar; the alkali of the burnt vegetables combining with the vitriolic acid, which in different states of combination is contained in most soils. Vitriolated tartar has very powerful effects in promoting vegetation." It promotes, as Mr. Senebier remarks, the decomposition of water. It will hereafter be seen, that hydrogen is a most active food of plants. Whatever, therefore, assists in this decomposition, must act a very important part in vegetation.

Mr. Fourcroy thinks, that the ashes of burnt vegetables, which have been supposed to consist of earth or clay,

of friability, which does not permit it to combine with any other substance; the sulphuric acid, which most clays contain, is dissipated; the iron and the clay itself are oxygenated, and a faculty in some cases to generate nitre is given. In its burnt state, also, it has a power of combining with the salt of urine. Burnt clays, when strewed on the ground, says Dr. Darwin, may contribute to vegetation, by their parting with their oxygen in a fluid not a gaseous form; which, united with carbon, or phosphorus, or nitrogen, might supply nutritious fluids to the roots of vegetables. Its texture is extremely beneficial in dividing and attenuating the harshness of stiff soils, and rendering them more absorbent. These circumstances are amply sufficient to account for the benefit which many persons have derived from the practice of burning clay and marles. Mr. Leslie, in Ireland, made great exertions in this way; Mr. White Parsons has burnt the earth out of ditches and drains successfully; and Mr. Boys, in Kent, has been long in the habit of doing it; paying his men six pence *per* load of ashes for digging and burning.

CHAPTER VI.

Paring and Burning.

These are mechanical operations; and though nothing is directly added to the soil by them, yet the effects are in many instances very extraordinary, and as such ought to be treated of here. There is no subject in husbandry about which so many misconceptions are afloat, or such misrepresentations hazarded, as on this.

§ 1.

§ 2. *The Properties of the Ashes, resulting from Paring and Burning.*

Vegetable ashes imbibe carbonic acid from the atmosphere *. They act in decomposition, and yield three-fourths in carbonic acid, and one-fourth a little inflammable; and last many years, by re-absorbing in winter the principles they had lost in summer †.

I imagine that the advantage of paring and burning some soils depends on the heat emitted from the burning vegetable fibres uniting oxygen with the clay, which forms more than the half of the slices of turf as they are dug from the ground ‡.

That the ashes produced by paring and burning operate as a very powerful manure, cannot be doubted; since in nine-tenths of the trials that have been made through the wide range of so many counties, the crops which followed have been found to be very great indeed, and generally superior to those procured by means of any other manure. It is not the want of this success that has made so many enemies to the practice, but rather the contrary; the crops have been so large, and so often repeated, *because great*, that the soil has been left in a state of exhaustion.

This is a subject that demands the attention of the experimental chemist more than most others in the theory of agriculture. The examinations which have been made on the ashes of vegetables, and of earths, will account for a certain degree of benefit resulting from their use; but perhaps it does not fully account for the enormous crops which are gained by the operation of paring and burning. I have gone through not an inconsiderable

* Priestley. † Fabbroni. ‡ Darwin.

course

course of reading, with a view to discover the theory of this fact; but my research has not entirely satisfied me. The formation of charcoal, sulphate of tartar, and phosphate of lime, with the decomposition of water, and the oxygenation of clay, added to the mechanical change effected by the fire, may certainly account for a considerable part of the improvement.

§ 3.—*The Paring and the Burning.*

The common practice is to pare from two inches on peat soils to half an inch on others: an inch is the more general depth.

Mr. Wilkes, of Derbyshire, has ploughed nine inches deep, and burnt the whole furrow with the assistance of coal *slack*; manuring double the quantity of land burnt, but working an immense improvement on the space thus deeply burnt. I have seen other cases in which four inches depth was burnt with great success. In the fens of Cambridgeshire the paring is done with a plough, and the depth from one inch to two. On sand the paring should be as shallow as possible.

The chief attention paid in burning is to guard against too great a calcination; as the general opinion of those who have most practised this husbandry is, that the turfs should be rather scorched or charred than reduced to ashes. If burnt during a brisk wind, sands frequently vitrify, and will not afterwards in many years, if ever, be restored to a state capable of contributing any thing to the support of vegetables: hence it is a practice with those who are aware of it, prior to burning, to shake out, in dry weather, from the grass roots, the greatest part of their substance with barrows. The heaps should always be small, and the fire be applied on the sheltered sides of them: this method, in a degree, should be re-

guided in the burning of earths of almost every kind; as hereby alone a carbonized substance, called the black ash, will be obtained, instead of a red brick earth, of much less fertility in the outset, and afterwards less susceptible of its principles as imbibed from the atmosphere.

In practice, however, as I have found more than once on my own farm, other circumstances will govern this point; such as, the weather in drying the turf, the depth to which pared, and the age of the grass; for these points have all an influence on the size of the heaps.

§ 4.—*State in which the Ashes are applied.*

Here occurs a considerable variation in common practice. There are two methods: one, to spread and plough in immediately; the other, to spread immediately, but to leave them exposed to the atmosphere some months before turning in. Mr. Wedge, on the thin sand soil on a chalk bottom of Newmarket-heath, had in one field a treble experiment; part was pared and burnt in the spring, and the ashes spread and exposed till ploughing in the autumn for wheat; part pared and burnt late, the ashes left in heaps, and spread just before ploughing for wheat; the third pared, and not burnt at all, by reason of bad weather. The first was by far the best; the second the next; and the third beyond all comparison inferior. This seems to be a decided proof that the ashes absorb some matter from the atmosphere, which adds to their fertilizing qualities.

§ 5.—*Application.*

The circumstances which may with propriety be touched on under this head, are,

1st. Spreading.

2d. Depth of tillage.

The

The fact of the ashes improving more after having been for some time exposed to the atmosphere, was probably the motive which induced Mr. Tuke, of York, to pursue on the wolds of Lincoln a practice that deserves attention. It is to pare along the centre of the lands a width sufficient for the heaps and burning; to move the sods, in order to plough the breadth; then to plough it; to make the heaps for burning on the land so ploughed; by which means all the land may be ploughed before the ashes are spread, and by this means kept on the surface: two material objects being attained, 1st, the exposition of the ashes, and, 2d, they are not ploughed to the bottom of the furrow, but kept on the surface to combine with the land, and early sinking prevented.

Evenness of spreading is always a material object, whatever may be the manure.

The universal practice (except in one very singular instance) is to plough the first time very shallow. A multiplicity of observations have convinced the farmers in almost every part of the kingdom, that these ashes have a tendency to sink; and the aim has therefore been to keep them near the surface by shallow tillage, especially at first. The method of ploughing before they are spread, entirely obviates the necessity of such a practice.

§ 7.—*Season.*

As the work can only be done in dry weather, it is usually begun in March, in which month the N. E. winds are more drying than at any other time. When the space to be burned is large, it is continued till September; and as the ashes are the better for exposition to the atmosphere, any crop may be put in that best suits the farmer's conveniency.

Mr. Dalton, of Yorkshire, on a dry loam on lime-stone and gravel. "It is a mere chimera to suppose that the soil is diminished by paring and burning. I have done it in the same field twice in the course of fifteen years, and could not discover it in the smallest degree *." On a light loam in Cornwall, Mr. Ans observes, "I was not *singularly* misled by speculative writers (who, I fear, have much to answer for) to think that burning caused a lasting injury to the earth. I fallowed three fields. I expected them to continue free from moss beyond the common period of its return. I found myself much mistaken; besides the crops failing, like those of some of my neighbours who had not burned, the moss returned as usual. Hence I and all my fellow-sufferers from fallowing have totally abandoned this practice, and stick to the antient one of burning."

"It has been the practice of a friend of mine, and his father before him, and of others before them, for near a century past, (the estate having been in the family for many generations,) on their thin lime-stone land, constantly to pare and burn after ten years' grass. The soil is so thin that the plough scalps the rock; yet no diminution of soil is in the least discovered †."

Sand.

"Upon sand I have tried paring and burning, but unsuccessfully ‡." But Colonel Vavasour speaks of it favourably on this soil, and from experience. Quere, whether this difference of result did not hold to their courses of crops? The former speaks, in another case, of two crops of wheat and one of oats. The latter, 1, turnips, 2, buck-wheat, 3, seeds. If Mr. Wright looked

* Communication to the Board of Agriculture.

† Mr. Wright. ‡ Ibid.

on

on sand for corn, and not grass, no wonder he was unsuccessful.

Chalk.

Mr. Boys, near Sandwich, in 1783, pared and burnt twenty acres of loose dry chalk mould, four inches deep, on a hard chalk rock, value 1*s. per* acre, and sowed barley and sainfoin in March. His whole expense, barley crop included, 53*l.* Produce sixty-six quarters of barley, at 26*s.* 8*d.*: his *profit* 33*l.* or the fee-simple of the land at twenty-two years purchase, the then price. The sainfoin took well *. In 1795 he writes to the author of the periodical work just quoted, "Should any of your friends, who so much condemn paring and burning, come into Kent this summer, I can shew them several scores of acres of wheat, barley, oats, and sainfoin, now growing on land which has several times undergone the operation: the crops of sufficient value to purchase the land at more than forty years purchase, at a fairly-estimated rent, before the improvement. This will be ocular demonstration to them."

Peat.

Twenty years past a field of coarse rushy land was broken up; part pared and burnt, the rest not. Whilst in tillage the part burnt yielded crops uniformly better than the others. It has been down to grass several years; the burnt part is quite free from rushes, and covered with a good sweet herbage; the other part full of rushes, and the herbage coarse †.

Mr. Simpson says, "I ploughed ten acres of moor, on a lime-stone bottom, in the part most free from ling, without burning; and I have had sufficient cause to re-

* Annals. † North Riding Report.

pent it, for I have not had even one middling crop since; and although laid down with seeds, they have by no means so good an appearance as those sown the same year on similar soils after burning, although I have expended as much lime and manure on this as on any part of the farm *."

Near Orton, on a peat moss, six or eight inches deep, on a stiff bluish clay; the only vegetable produce spongy moss, bent grass, dwarf rush, &c. wet and not drained; pared three inches deep, and burnt in the spring; then manured with thirty bushels of lime an acre; ploughed slightly for turnips, which were not hoed. They were worth 3*l.* an acre; and being sown with oats, produced seventy bushels *per* acre †.

Miss Graham was the first that pared and burnt moss in Monteith. Several acres that were burnt above forty years ago continue to carry a close sward of green grass at this day, without a single pile of heath ‡.

" Of all the methods of breaking up peaty soils which I have practised or seen, the best mode is paring and burning. I have seen various methods on several thousand acres, but none ever equalled this §."

* North Riding Report.
† Todd. Society's Transactions.
‡ Perth Report.
§ Bailey.

TO BE CONTINUED IN OUR NEXT.

Description

Description of an improved Crane and Flexible Chains.

Invented by Mr. GILBERT GILPIN, *of Old Park Iron-Works, near Shifnal.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Thirty Guineas were voted by the Society to Mr. GILPIN *for these Inventions.*

HAVING discovered a method of working chains of the common construction, over pullies, in all directions, more safe and flexible than the best hempen ropes, and at the same time equally uniform, I have sent by the Shrewsbury waggon, for the inspection of the Society for the Encouragement of Arts, Manufactures, and Commerce, a full-sized pulley in wood, and a piece of a chain, together with a model of a crane, exhibiting its manner of application.

From its simplicity of form, and facility of manufacture, the common chain, formed of oval links, has been in use from the earliest ages; and that it did not answer every purpose of a hempen rope in working over pullies, was not owing to its peculiar form, but from an error in the application.

Every chain of this nature has a twist in itself, arising from a depression given by the hammer to each link in the welding *; and this circumstance, so trifling in appearance, is not so in its effects, and it has in consequence a perpetual tendency (even when reefed per-

* The twist may be seen by holding the piece of the chain by one end, and viewing the links edgeways as it hangs down.

fectly straight in pullies, and on the barrels of cranes) to assume a spiral form, which a plain cylindrical barrel, and the common pullies with semi-circular grooves, are not in the least calculated to prevent. Hence the alternate links of the chain, in coiling round a barrel, or working over pullies, form obtuse angles in assuming the spiral form, bearing upon the lower parts of their circumferences, and forming as it were two levers, which wrench open and crush each other in proportion to the weight suspended, as well as prevent the freedom of motion in the links themselves, and thereby load the chain with additional friction.

A still greater obstruction to the uniformity of its motion, is the tendency which the chain has to make a double coil as it approaches the middle of the barrel and crosses its centre, and that of the pullies at right angles, by means of which the chain is frequently broken by the sudden jerk caused by the upper coil slipping off the undermost.

It is to these causes that all the accidents that occur to workmen and machinery from the failure of chains may be attributed, (bad iron excepted,) and which form the sole objection to their becoming a general substitute for ropes.

As a preventive to these evils, I have grooves cast in iron pullies, of sufficient dimensions to receive the lower circumferences of the links of the chain, which work vertically; those which work horizontally and form the gudgeon part of the chain, (if we may be allowed the expression,) bearing upon each side of the grooves.

The barrels are also of cast-iron, with spiral grooves of the same dimensions, at such distance from each other as to admit the chain to bed without the danger of a double coil; by these means the links are retained at right

right angles with each other, the only position for free and uniform motion.

The links of the chains are made as short as possible, for the purpose of increasing their flexibility; and they are reefed perfectly free from twist, in the pullies, and on the barrels, for the same reason.

When applied in blocks, the grooves in the pullies prevent the different falls of the chain from coming in contact, and render plates between them (as in the common way) totally unnecessary; the pullies are in consequence brought closer together, the angle of the fall from block to block considerably diminished, and the friction against the plates entirely avoided. Brass guards, with grooves opposite to those in the pullies, are riveted to the blocks, to prevent the chain getting out of its birth from any accidental circumstance. This method of working chains I first put in practice for Messrs. T. W. and B. Botfield, at these works, in July last; and it is applied in the working of cranes capable of purchasing from ten to fifteen tons; in the working of the governor balls of steam-engines, constructed by Messrs. Boulton and Watt, and in the raising of coal and ore from the mines, for which purposes ropes had before been solely used at this manufactory. In all cases it has performed with the utmost safety, uniformity, and flexibility; so much so, that the prejudices of our workmen against chains are entirely done away, and they hoist the heaviest articles with more ease, and as great confidence of safety, as they would with the best ropes.

The same method is applicable, at a trifling expense, to all machines at present worked by ropes, or by chains, in the usual way: and all the common chains now in use may be applied to it with equal facility.

With a view of ascertaining the relative flexibility of ropes and chains, I wedged an iron pulley thirty-one and

and a half inches in diameter, on the spindle of the pinion of a crane of the following description, *viz.*

Barrel 30 inches diameter.
Wheel 64 teeth.
Pinion 8 ditto.
Top block, with 3 pullies of 12 inches diameter.
Bottom block, with 2 ditto, ditto.

To the large pulley I attached a small rope, for the purpose of suspending the weights in the hoisting of the different loads, and the results were as follow :

The crane was loaded with	Took to hoist the loads when reefed with the chain in grooved pullies *.	Ditto when reefed with a half-worn tarred strand-laid rope, 3¼ inches in circumference.	Ditto when reefed with the chain promiscuously, as in the common way.
lbs.	lbs.	lbs.	lbs.
First - - 2000	63	74	80
Second - 1000	32	39	41
Third - 500	17	21	22
Total - 3500	112	134	143

The flexibility is inversely as these momenta, and proves the superiority of chains ; for (on the average of the trials) with the chain in the grooves,

One pound raised - - 31,25 lbs.
With a half-worn strand-laid tarred rope, three inches and a half in circumference 26,11 do.
And with the chain in the usual way, only 24,47 do.

* All the experiments were tried with the same grooved pullies.

It

It also appears (contrary to the general opinion), that chains are safer than ropes; for it is an established axiom, that those bodies whose fibres are most in the direction of the strain, are the least liable to be pulled asunder; and in our examination of the properties of a rope, we find that the strands cross the direction of the strain in undulated lines, and consequently prevent its uniform action thereon. A rope is subject to this inconvenience even when stretched in a direct line, but more particularly so when bent over a pulley, as in that position the upper section moving through a greater space than the under one, is acted upon by the whole strain; and hence the frequent breaking of ropes in bending over pullies, from the double strain overloading the strands of which the upper section is formed.

The links of a chain are subject to the transverse strain, where they move in contact; but as such strain is in proportion to the length of the bearing, it must be very trifling. All the links having axles of their own, *the chain moves simultaneously with the strain, and both are in consequence retained in continual equilibrio.* A chain in grooves will therefore sustain as great a weight when bent over a pulley, as it will in a direct line, and consequently is safer than a rope.

A safe, uniform, and flexible method of applying chains in the working of machinery, has long been a desideratum in the arts; for they are but little affected by exposure to the weather, or the heat of manufactories, whilst either produces the speedy destruction of ropes.

The discovery is of additional importance, as it substitutes a durable article for a very perishable one, and gives employment to our own manufactories at the expense of foreign importations.—The durability is at least six to one in favour of chains.

Though

Though the model of the crane is chiefly intended to convey a proper idea of the new method of working chains, yet I trust it will be found to possess several other advantages in point of construction, which are entirely new, and calculated to increase the safety and durability, as well as to lessen the expense of that useful machine.

On reviewing the principles of a crane, we find that the gudgeons are the points of resistance to the machine and its load, and consequently the effect of the transverse strain upon the perpendicular will be in proportion to the distance of the mortise for the gib from the upper one; and that of the oblique strain, in proportion to the distance of the mortise for the diagonal stay, from the lower one.

Notwithstanding these circumstances are so evident, they are seldom attended to; for in general a large and expensive piece of oak, sufficient of itself to make a crane of double the purchase, forms the perpendicular; the gib is mortised into it, at eighteen or twenty inches from the top, to make room for the gudgeon, as is the diagonal stay, at five or six feet from the bottom, to allow a birth below for the barrel. Thus the effect of the transverse and oblique strains of the gib and diagonal stay upon the perpendicular, is increased by their distances from the gudgeons, or points of resistance, and the perpendicular itself considerably weakened by mortises made where the greatest strength is required. Hence the frequent failure of cranes of the common construction, by the breaking of the perpendiculars in the mortises.

It appears, however, that the various parts of a crane formed of wood cannot be connected together in any other way than by mortising; and as this method *considerably diminishes the strength of the timber*, I make use of cast-iron mortise pieces.

The

The perpendicular is formed of two oak planks, each eighteen inches wide, four thick, and sixteen feet long; these, at the top and bottom, are let into cast-iron mortise pieces, which retain the planks ten inches asunder. The barrel for the chain works between them. The piece at the top contains in the middle a dove-tailed mortise, into which a stock for the gib is fixed; for greater security, an iron bolt goes through the whole; the stock projects two feet from the mortise, and a plank, eighteen inches deep and four thick, is bolted to each side of it to form the gib, the interstice between the planks forming a birth for the top block to slide in. The diagonal stay is of the same dimensions, formed in a similar manner, and connected to the perpendicular, by being let into the lower mortise piece.

In this mode of construction scarcely any part of the timber is cut away; and the strength of the materials, so far from being diminished, is augmented by the cast-iron mortise pieces, the gib is brought much closer to the upper gudgeon, and the centre lines of the perpendicular and the diagonal stay, crossing each other at the top of the lower one, places the whole strain as near as possible in a line with the gudgeons. The business of the perpendicular becomes in consequence little more than that of a mere prop, and consequently requires no greater strength of materials than the diagonal stay.

The top block is made of cast iron, and has a groove three inches deep on each side, for the purpose of embracing the planks which form the gib.

To prevent the inconvenience of the dirt of the floor getting into the brass of the lower gudgeon, and thereby obstructing the revolution of the crane, those parts are reverse to the common way, the gudgeon being fixed in the floor, and the socket part which embraces it is cast

in the bottom of the mortise-piece, as is also a channel to convey oil to the gudgeon.

REFERENCE to Plate V. Figs. 1, 2, 3, 4, and 5.

Fig. 1, Represents the crane with all its parts complete, ready for work. A B, The perpendicular, formed of two oaken planks, each eighteen inches wide, four thick, and sixteen feet long, let into cast-iron mortise pieces C D. E E, the barrel for the chain, which works between the two planks of the perpendicular. F, the top piece, containing in the middle a dove-tailed mortise, into which H, a stock for the gib, is fixed; an iron bolt goes through the whole, for greater security. The stock projects two feet from the mortise, and two planks I, K, eighteen inches deep, and four thick, are bolted one on each side of it, to form the gib, the interstices between these planks forming a birth or space for the top block L to slide in. This block is made of cast iron, and has a groove three inches deep on each side. M, the diagonal stay, is of the same dimensions as the gib, formed in a similar manner, and connected to the perpendicular by being let into the lower mortise-piece D. N, the handle or wince which turns a small pinion O, fixed on the same axis; this pinion works in the teeth of the wheel P, moving on the same axle as the barrel E, on which the chain R lies in spiral grooves. S, the block and hook by which the goods are raised.

Fig. 2, Is a side view of the handle N, the pinion O the toothed wheel, and the barrel E placed betwixt the two uprights A B.

Fig. 3, Shews upon an enlarged scale part of the barrel E, and some of the chain lying in its proper position in one of the spiral grooves, or channels; it is to be noted that the lower edge of one link lies in the groove, and

and the next link upon the surface of the barrel, and that by this means the chain is prevented from twisting in winding upon the barrel.

Fig. 4, Shews a section of part of the barrel E, in order to point out clearly the manner in which one link lies within it, the other link on its outside. It is contrasted by Fig. 5, the old method of working chains.

Certificates, dated November 22d, 1804, from Thomas Blackmore, John Swift, John Ball, Joseph Felton, Benjamin Heylehurst, Benjamin Hunt, and Thomas Hatchhess; who declare that they were present at the trial of the experiments above mentioned, that they had also seen the new method of working chains in daily use for upwards of sixteen months, and are certain, that in that way chains work much more flexible than hempen ropes, and equally as safe and uniform.

Further certificates from Messrs. I. W. and B. Botfield, lessees of Old Park Iron-works, and Isaac Hawkins Browne, Esq. landlord of the said works, confirm Mr. Gilpin's statement; and further add, that the method is calculated for chains of all sizes, and for machinery of every description; that it is employed at their works with great success, in the working of cranes and mill machinery, and in the raising of coal and ore from the mines. That his chains applied in this manner are a complete substitute for ropes, and will prevent those fatal accidents which too frequently occur to the workmen and machinery, in the working of chains in the usual way. That Mr. Gilpin's crane is also constructed upon stronger and more durable principles than those in general use, and completely answers its purpose.

Description of a Machine for the Use of Shoe-makers, to enable them to do their Work in a Standing Posture.

Invented by Mr. THOMAS PARKER, *New Cross-street, Leicester-Fields.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Fifteen Guineas were voted by the Society as a Premium for this Invention.

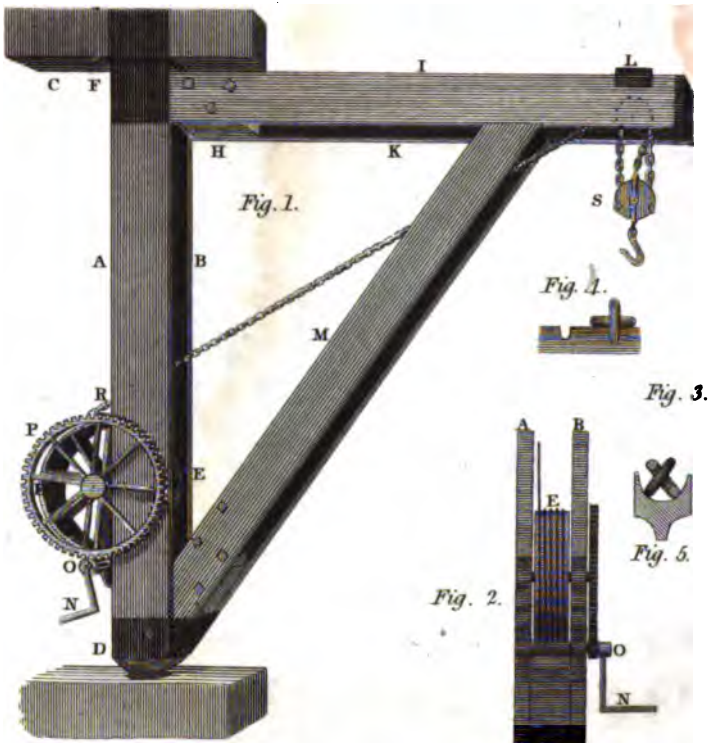
MR. Thomas Parker, the inventor of the machine, was desired to attend with it upon a committee appointed by the Society, on the 22d of November, 1804, and then informed them, that he had used this apparatus for twelve months past, and found it very useful. That all the work of shoe-making may be done therewith standing; but that in some parts thereof he finds an advantage in using along with it a high stool; but that before he used this machine he never saw or heard of a similar invention; and that he has found it of great service to his health.

He stated the cost of such a machine to be about two guineas.

REFERENCES to Plate V. Figs. 6 and 7.

Fig. 6, T, the bench, standing on four legs, about four feet on the ground. V, a circular cushion affixed to the bench, in the centre of which cushion is an open space quite through the bench, through which hole a leather strap U is brought up from below. This strap holds the work and last firm upon the cushion, in any position required, by means of the workman's foot placed

Pl. V. Vol. IX. Second Series.



placed upon the treadle W. X, shews the last upon the cushion, with the strap holding it firm. Y, an implement used in closing boots. Z, a small flat leather cushion, useful in adjusting the last and strap.

Fig. 7, the shoe-last, shewn separate from the cushion. The round cushion is formed of a circular piece of wood, covered with leather, and stuffed with wool or hair, to give it some elasticity.

Description of several new and improved Tools applicable to Lathes, &c. by Mr. J. I. HAWKINS, *Dalby Terrace, City Road.*

Communicated by him in a Letter to the Editors.

With a Plate.

GENTLEMEN,

ACCORDING to my promise in the forty-eighth number of your Repertory, I send you a description of some useful tools not generally known.

Among the useful apparatus attached to turning lathes for facilitating work, what is termed a wire chock, upon a good plan, has been much wanted. The following idea occurred to me a year or two since, from which I have had one made, and in use for some time past.

Fig. 1, (Plate VI.) is a perspective view of the wire chock.

Fig. 2, an end view of the same.

Fig. 3, an end view of the same, with the covering plate taken off, to shew the dies.

The letters of reference are the same in each figure.

a, the wire to be held fast by the chock.

b, three dies, each about three quarters of an inch long, which are forced upon the wire by the screws *c*.

d, screws

d, screws to fasten that part *(f)* of the chock which is perforated for the dies, on to the part *g* screwed to the mandril of the lathe.

e, screws to fasten a plate *h* over the dies to keep them in their places.

Two of the dies have two screws, one acting near each end; and the other die only one screw, acting about the middle: the advantage of which contrivance is, that the wire, if in itself straight, can be brought into the axis of the chock throughout its whole length. Another advantage is, that the chock requires no particular accuracy in its construction, as it has, by means of the screws, the power of remedying the defects of bad workmanship.

Fig. 4, is an enlarged view of one of the dies and screw. A, a perspective view of the die, with a dove-tailed groove in the back. B, the screw, terminated by an inverted frustrum of a cone, to fit into the dove-tailed groove of the die; by which means the screw draws the die backward as well as forces it forward. The sharp edge of the die is taken off at *f*, so that it may not indent the wire which is held by it. I prefer making the heads of the screws square, and with a notch also; by which means they are turned either by screw-driver or a pair of pliers. It is evident from this construction of a wire chock, that after the wire has been, once adjusted, the turning of one screw will release it; and when that one screw is forced on the wire, it is held firmly in every direction.

There are two tools, the inventor of which I do not know, but as I find them very useful in making metal screws, and they are not generally known, I think they have a claim to publication. One is a tool for making a conical point to a wire: it is made of a piece of round steel,

steel, by filing two deep notches in the end crossing each other at right angles. Two views of it are shewn at A and B, Fig. 5.

This tool is either held in the hand and the wire fixed in the chock, or the tool put in the chock and the wire held by a hand-vice in the hand.

The other tool is for making the cylindric body of a screw preparatory to tapping: this is made by drilling a hole in the end of a piece of steel the size and depth of the screw required, and then cutting that part surrounding the hole into teeth like a saw or coarse file; if the shoulder of the screw be required square, the tool must be flat at the end, but if conical, the tool must be made of the same shape; this tool may be used in the same manner as the last.

C, Fig. 5, is a section of the tool. D and E are two views of the end cut in different ways.

The point of the wire *a*, Fig. 1, is shewn as having been formed by this tool.

In making screws in general much time is wasted, owing to the slowness with which the screw plate or dies, and also the tap, are turned round by hand. I therefore some years since contrived to fix a die stock on the end of a small hollow mandril, fitted to a frame which could be put into the bench vice when wanted, and turned by a winch, and a socket to receive taps on a mandril in another frame. The good effects of which plan are, that four or five times the quantity of work may be done by it, than is done in the common way; and, the screws will be much better made.

Fig. 6, A perspective view of the die-stock and mandril in its frame. *a*, the frame to be put into the vice. *b*, the mandril. *c*, the die stocks; and *d*, the winch.

Fig. 7, Shews the frame and mandril with a tap fixed in it.

A tool

A tool for speedily making square or other shaped holes in metal plates was shewn me by the same ingenious Englishman in Philadelphia, mentioned in my former paper. I have had several made, and find them particularly useful. This tool consists of a taper piece of steel made the shape of the hole, with teeth cut obliquely across all its sides; this tool is used with the hammer, and does not strain the metal to injure it.

Fig. 8, represents a punch for making square holes; but supposing all the four sides of it could be seen at once, it would appear as in Fig. 9; this figure is given to shew the necessary degree of the obliquity of the teeth. They are reversed alternately to prevent the tool having any tendency to twist in driving in.

Yours, &c.

June 4, 1806. JOHN I. HAWKINS.

Experiments on the Quantitative Proportions of the Sulphuric Acid. By M. KLAPROTH.

From GEHLEN'S CHEMICAL JOURNAL.

THE sulphuric acid maintains one of the first places among the chemical agents, on account of its great affinity for the alkalies, earths, and metallic oxyds. The investigation of its nature, and of the principles which compose it, was therefore in the earliest period of the improvement of chemistry by scientific cultivation, an object which in various ways employed the industry of chemists.

As long, however, as no other method of procuring this acid was known, than by distillation from the vitriol of iron, it could hardly be suspected that sulphur was the basis of this vitriolic acid.

Boyle,

Fig. 2.

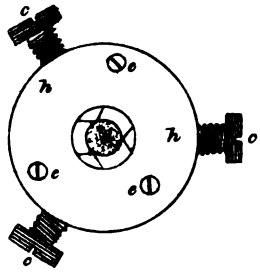


Fig. 3

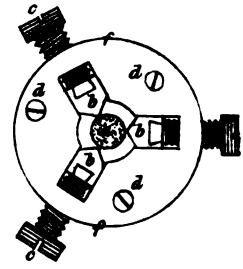


Fig. 1.

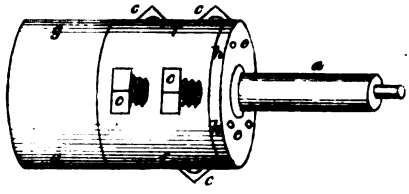


Fig. 4.

Fig. 9.

Fig. 8.

Fig. 5.

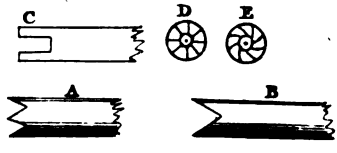


Fig. 6.

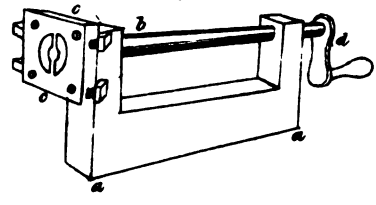


Fig. 7.

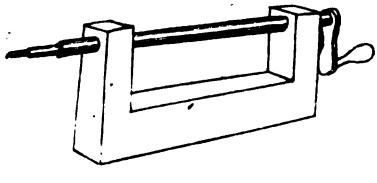
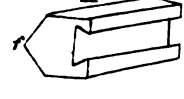


Fig. 4.



Boyle, in his work, intituled, "The Sceptical Chemist," first taught the artificial preparation of sulphur, by decomposition of the sulphuric acid by turpentine, upon which experiment Kunkel, Geoffroy, and others, have farther extended the proof of the supposed composition of sulphur. The celebrated analytical and synthetical experiments are well known, by which Stahl *, and with him all the succeeding chemists down to the most modern period of chemistry, imagined the proof that sulphur consisted of vitriolic acid and phlogiston to be brought to the most complete evidence, and according to which Brandt † determined the proportion of the constituent principles of sulphur to be 93,44 vitriolic acid and 5,66 phlogiston, or 6 parts phlogiston in 100 parts of vitriolic acid.

The invention of the method, which at present is almost universally followed, to prepare this acid by the combustion of sulphur in close vessels or rooms, with a small addition of nitre, is attributed by some to Doctor Ward, of England, by others to Dossie in conjunction with the celebrated Dutch inventor of the thermometer, Cornelius Drebbel.

The aetiology of this process was, however, involved in obscurity till the theory of oxygene was established; according to which we now consider sulphur as a chemically simple substance, and the vitriolic acid as a product of the combination of sulphur with oxygene, consequently as proper sulphuric acid.

For discovering and determining the relative proportions of the sulphur and the oxygene in sulphuric acid, the above process is however not properly adapted. This

* Observationes chymico-physico-medicæ Curiosæ, M. Julio, 1697.

† Transactions of the Royal Academy of Sweden, for the year 1756.

object may be attained with greater certainty by treating the sulphur with nitric acid; in which operation the latter furnishes the oxygene requisite for the acidification of the sulphur.

The knowledge of this process of converting sulphur into sulphuric acid by means of nitric acid is, however, of greater antiquity than seems generally to be believed. Even Paracelsus mentions it. But a circumstantial detail of the mode of performing it is to be found in a work published in the seventeenth century, which at present is but little known, and which is intituled, "*Pratique de Chimie, divisée en quatre parties, par J. Matte la Faveur, Destillateur et Demonstrateur ordinaire de la Chimie en la faculté de Médécine à Montpellier. Par Dan. Peck, Imprimeur ordinaire du Roi*, 1671," in 12mo. In chap. V. p. 216, the following descriptions are given for performing the process:

"*Spirit of Sulphur by the Retort.*

"Take sulphur in powder, put it into a retort, pour upon it spirit of nitre, so as to rise to the height of five or six finger-breadths above it; place this retort in the dry-bath, or upon the fire of ashes; adapt to it a receiver, and lute the joinings; then distil gradually till the last drop has passed over. The distilled liquor will be a green colour. Cohobate it three times, proceeding always as at the first distillation; let it cool, and you will find in the retort the oil of sulphur (vitriolic acid), which you will separate from this sulphur. If you put the same spirit of nitre again upon the sulphur in the same retort, you will be able to make of it new oil of sulphur; and continue in this manner, performing always the same distillation and cohobation, till the sulphur is dissolved, &c."

Since

Since the adoption of the doctrine of oxygene, the position, that the vitriolic acid, as it was formerly termed, consists of sulphur and oxygene, is no longer subject to any contradiction. Only in the determination of the quantitative relations of these two constituent principles, chemists have differed very materially from each other, as will appear from the following view.

100 parts of sulphuric acid in the concrete state are supposed to consist,

By Lavoisier	of 69	sulphur and	31	oxygene.
By Berthollet	72		28	
By Thenard	55,56		44,44	
By Chenevix	61,5		38,5	
By Tromsdorf	70		30	
By Richter	42,05		57,95	
By Bucholz	42,5		57,5	

Of these proportions those of the two last-mentioned chemists merit the greater attention; not only on account of the accuracy by which their inquiries are distinguished, but also because the great similarity between their results, though obtained in different ways, renders it probable that their proportions are the most correct.

I have, however, thought it necessary to ascertain, by my own experiments, the proportions of the constituent principles of sulphuric acid, especially in order that I might be enabled in the analyses of sulphurated ores to determine the quantity of the sulphur with greater accuracy than has perhaps been done in some of my earlier works. I have employed for this purpose the same means as most of the above-mentioned chemists; namely, nitric acid, in order, by means of its oxygene, to acidify the sulphur, and barytes, in order, in combination therewith,

to determine the quantity of sulphuric acid obtained. The applicability of barytes to this purpose depends upon the knowledge of the quantitative relations both of carbonic and of sulphuric acid to it, which it was therefore necessary previously to determine.

A.

The proportion of the constituent principles of pure carbonate of barytes, both the native or the Witherite, and the artificial, I have already specified in the first volume of my "Contributions," &c. to be 78 barytes to 22 carbonic acid. As, however, Bucholz * has since specified the proportion of the latter as less by 1 *per cent.* and that of the former as 1 *per cent.* more, consequently 79 barytes to 21 carbonic acid, I was induced once more to repeat this experiment.

Into a capacious phial of thin glass, provided with an open barometer tube eight inches in length, a mixture of two ounces of moderately-strong, not fuming, muriatic acid, and 6 ounces of water, was introduced, and brought into equilibrium in a balance. Into this 400 grains of the purest Witherite were gradually introduced in coarse fragments, which were put in singly, and the phial each time closed with the stopper. Under these circumstances neither a violent effervescence, nor an evaporation of the liquid could take place. After twenty-four hours, I found the loss of weight to be 88 grains, consequently amounting, as always, to 22 *per cent.*

In endeavouring to find the proportion of carbonic acid by the solution of alkaline, earthy, or metallic bases in acids, I generally take care that after the solution is

* Scherer's Chemical Journal, vol. X. p. 865.

completed

completed some free acid shall still remain, in order to prevent the retention of a part of the carbonic acid by the fluid which would otherwise be to be apprehended; for in the present case 9½ drachms of muriatic acid would have been sufficient for the mere solution of the 400 grains of Witherite.

B.

Also with regard to the determination of the proportions of the constituent principles of the calcined sulphate of barytes, a difference of opinion still prevails.

100 parts of it are supposed to contain,

By Fourcroy - - - -	66 barytes	34 concrete acid.
By Clement and Desormes	67,82	32,18
By Thenard - - - -	74,82	25,18
By Chenevix - - - -	76,5	23,5
By Kirwan - - - -	67	33
By Richter - - - -	69	31
By Bucholz - - - -	67,5	32,5

With exception of the two proportions given by Thenard and Chenevix, the remaining five coincide pretty nearly with each other, so that their mean term might in doubtful cases be considered as accurate; and it agrees also very well with the results of several of my experiments, according to which 100 grains of Witherite dissolved in muriatic acid, and precipitated by sulphuric acid, gave upon the average, with very trifling deviations, 116½ grains of well-edulcorated and calcined sulphate of barytes. According to these experiments I consider the proportions in the calcined sulphate of barytes to be, as Kirwan has specified them, 67 barytes to 33 concrete sulphuric acid.

C.

C.

a. Of my different experiments for converting sulphur, by treatment with nitric acid, into sulphuric acid, I shall first mention one which I made a considerable number of years since.

Three ounces of pure sulphur were repeatedly covered over in a retort with pure moderately-strong nitric acid, and the nitric acid each time distilled off until the sulphur was about to begin to sublime. After the operation had been stopped, the sulphur that remained was collected. It weighed 10½ drachms; consequently 13½ drachms had been converted into sulphuric acid. The whole of the fluid was distilled from a fresh retort until the portion that remained proved to be completely-concentrated sulphuric acid. The quantity of this obtained amounted to 4 ounces 7 drachms.

With this result I was contented; because at that time the barytes earth was not yet known, and could therefore not be employed for the determination of the quantity of acid, as it was, among others, in the following experiment made a short time since.

b. 200 grains of pure sulphur were covered in a retort with 8 ounces of pure nitric acid of 1,320 to 1000 of water, of specific weight, and ¾ of the acid drawn off with the requisite degree of heat. During the distillation the interior of the receiver and of the retort was constantly filled with red fumes. The acid drawn off, which exhibited a green colour, was again poured back after it had cooled, and the distillation repeated. After ¾ of the acid had again been drawn off, 8 ounces of nitric acid were again employed, and the distillation repeated a third time. The sulphur which remained weighed 48½ grains; consequently 151½ grains of sulphur had been converted

converted into sulphuric acid. The sulphuric acid obtained was, after sufficient dilution with water, mixed with a solution of muriate of barytes, until no farther precipitation or turbidity took place. The sulphate of barytes collected, after being well edulcorated, and completely dried, weighed 1,109 grains; but after calcination in a crucible of platina 1,082 grains.

D.

In order now to find also the proportion of concrete acid in the fluid concentrated sulphuric acid, 100 grains of rectified sulphuric acid, of the specific weight of 1,850 to 1000 water, (which, I must remark, is the highest degree of concentration to which I can bring the pure sulphuric acid,) were diluted with fifteen parts water, and mixed with solution of muriate of barytes until no farther precipitation took place. The sulphate of barytes that was formed, after being carefully collected, edulcorated, and after drying calcined, weighed 225 grains.

From these data we now obtain by calcination, with the omission of inconsiderable fractional parts, the following results.

1. 100 parts of concentrated sulphuric acid, of 1,850 specific weight, consist of,

Concrete sulphuric acid - - - - -	74,4
Essential water - - - - -	25,6
	100

Or, of

Sulphur - - - - - - - -	31,5
Oxygene - - - - - - -	42,9
Essential water - - - - -	25,6
	100

2.

2. 100 parts of sulphuric acid, *i. e.* concrete sulphuric acid, not to be exhibited by itself, contain,

Sulphur	42,3
Oxygene	57,7

3. 100 parts of calcined sulphate of barytes consist of,

Barytes	67
Concrete acid	33
	100

Or, of

Barytes	67
Sulphur	14
Oxygene	19
	100

4. 100 parts of sulphur gave, or can form,

Concrete sulphuric acid	236,5
Or, fluid sulphuric acid of 1,850 specific weight	317,5
Or, sulphate of barytes	714,25

These proportions approach the nearest to those which Bucholz has found in his experiments, made with great diligence, upon this subject *. The small differences between them arise, independent of the accidents which are almost unavoidable in chemical operations, chiefly from the circumstance, that Bucholz has taken the proportion of carbonic acid in the carbonate of barytes at only 21 *per cent.*; whereas the results of my experiments are calculated upon a proportion of 22 *per cent.*

* Scherer's Chemical Journal.

On Tinning. By Professor PROUST.

(Concluded from Page 50.)

XX. WE will now consider under the same circumstances the tin vessels used for making sherbet, since they continue to be a subject of alarm notwithstanding all we have said in a former treatise on tinning.

We have seen in this treatise, that the strongest vinegar may be left for three days in vessels alloyed with lead, without contracting any thing to render it dangerous. Let us therefore examine these same alloys, when exposed to the double action of the acids and the oxygen of the atmosphere.

Sherbet and lemonade vessels, which, from the nature of their service, are much oftener half empty than full, are undoubtedly more liable to waste from this assemblage of causes which, as we have shewn in the case of copper, so easily effect the dissolution of metals; but is there any reason to fear on this account, that the acid will attack the lead rather than the tin.

The vessels made of the alloy which is used to prove vinegar, may be considered as so many sherbet vessels, and there is no doubt that the results will prove the same, since the alloy is in the same proportions; which are, 5, 10, 15, 20, 25, 30, and 50 *per cent.* of tin; these proportions are used by the makers, and comprehend all the different kinds of tinning that are made.

XXI. Now let us consider the principal acid beverages; the active principle of lemon and verjuice having been known to be of the same nature, I deemed it sufficient to make the following experiments on lemon only. It is customary with lemonade-makers to put the juice of two middle-sized lemons into four pounds of water. A mid-

dle-sized lemon with a thin rind, gives from 13 to 14 drams of juice; but, to be above rather than below the mark, we will take sixteen, and consequently 4 ounces of the juice should be mixed with 4 pounds of water to make good lemonade. It is in this way that all the lemonade-makers in Madrid compose this beverage, which they assert would certainly become poisonous, if the vessels in which it is kept were not made of pure tin.

This liquor remained twenty-four hours in each of our vessels, in order to undergo an analysis afterwards; but as it was necessary to know first, how to attain the greatest action of the lemon to prove our vessels, it appeared to me that I ought to begin with the following experiments.

XXII. I made a mixture of equal parts of the juice of lemon and water, which forms a liquor fifteen times stronger than ordinary lemonade, which, as we have before observed, contains but a sixteenth part of the juice; about two ounces of the above mixture were afterwards poured into each of our eight vessels, the first of which was composed of pure tin, and the following at 10, 15, 20, 25, 30, and 50 *per cent.* In each of them was put a pidgeon's feather in order to wet it all over as often as it was judged necessary, and to put the surface in successive contact with the acid and the atmospheric oxygen. The experiment lasted 24 hours. The following phenomena presented themselves.

In less than half an hour a white dust hung upon the surface of the inside of the vessels above the liquid. It began to appear first in that of pure tin, and afterwards in those of 5, 10, and 15; it became less sensible in those of 20 and 25, and was scarcely perceptible in those of 30 and 50. This powder or this oxyd, which I took care to let fall into the liquid, by washing it off with the feather,

ther, did not dissolve at all, and even at the end of 24 hours it was so abundant in the vessel of pure tin, and the four following ones, that the liquid was become quite milky. The liquid of these eight vessels was thrown upon a filter, washed with water, distilled and poured into eight glasses; to each of these I immediately added some of the solution of sulphate of potash, the most certain reactive for precipitating the smallest quantity of lead, but it occasioned no alteration in any of the liquids. And even after forty-eight hours' rest, there was no sediment to be perceived. In short these liquids, examined relatively to the tin, gave all the signs of its dissolution which are peculiar to it; and the white powder collected by the filter proved to be only a pure oxyd of tin. Such was the effect of a lemon-water fifteen times more active than usual; such were the appearances of this imaginary poison, of which an hereditary dread has so long made us afraid, and which the poison of personal interest has attempted to prolong.

Some lemonade of the customary strength was afterwards kept for 24 hours in the eight vessels, and was examined with the sulphate as the other had been; the issue was the same, not the least trace of lead was perceptible. The following experiment is a demonstration not less convincing, even to those who are not well acquainted with the properties of metals.

An equal portion of the liquors contained in the vessel of pure tin, and in that of which the metal was as 50 to 100, was poured into two glasses, some hydro-sulphureted water was then added to them, and they immediately took that chesnut shade which tin always gives when it is at its least oxydation. If this colour proceeded from lead, we certainly should not be surprized to see it appear in the liquor which came out from a vessel partly formed of

that metal; but the liquor from the vessel of pure tin gave the same shade, consequently the acid of lemon extracted the same metal from two vessels very differently composed. The metal then which is dissolved by these acid liquors, is not that which the sulphate of potash indubitably precipitates wherever it meets with it; but it is the tin which is dissolved, and no known experiment has ever yet proved this metal to be dangerous.

XXIII. All these facts authorise us to conclude with confidence, that lead is a metal which cannot introduce itself into acids, while tin is present; its affinities are so much superior to those of lead, that they form an invincible obstacle to its solution in any solvent whatever. Thus, wherever there is tin the lead can never infect our liquors. This fact is irrefragable, because it is a law of nature. But how often are disorders erroneously attributed to acid liquors, which happen to attack a short time after those liquors have been taken? and how often do complaints proceed from internal and external perspiration being too suddenly suspended, rather than from any bad quality in the liquors?

How dangerous is it for people of delicate constitutions, who, while in a profuse perspiration, have the imprudence to brave this perilous opposition of temperature!

Since these facts dissipate exaggeration, lead us to more definite ideas, and convince us nevertheless, that if lead ought to be, as I have said, at each step prohibited from tinning in general, because it is unnecessary, and diminished in our pewter wares, because we would have good tin, we must not for that reason exclaim against a vessel that a careless and unprincipled workman may have tinned with an alloy containing too much lead, and which he would endeavour to sell as fine tin. Let us detect the fraud; but let us not confound it with that most dreadful crime,

crime, the crime of poisoning. It is worthy of remark, that, during several years in which it has been endeavoured to frighten Madrid from using a mixture of lead and tin, the public have continued to use with perfect security, both tin and pewter wares without troubling themselves to consider whether they were made according to law or not. Wiser than those who are alarmed by simple rumours, they found their confidence on this, that, in all the extent of a large kingdom, no one has been able to justify the reports raised against it, by a single accident satisfactorily stated before the tribunal of sciences.

Consequences.

1. The confectioners may continue with safety to use pans untinned, so long as they scrupulously observe the precautions which the rules of their trade dictate, and they will be personally responsible if any of their preparations be found to contain poison.

2. All measures tending to force them to use tinned vessels would be fallacious, since the heat that most of their compositions require, in order to dress them properly, would destroy the tinning in a few days. I caused various sweetmeats, which require a great heat, to be made under my own inspection, in vessels tinned with fine tin, and the workman could not succeed, for some came out quite candied, and others almost burnt; the tin was detached or rubbed off in several places by the friction of the spatula, and the copper was quite visible. How much worse it must be when there are fifty pounds of sugar to be prepared, or other things in the same proportion, which must be kept dry to complete them, and to bring them to a proper consistency.

3. Tinning mixed with lead, even to equal parts, cannot be dangerous, since it is sufficient for lead to be alloyed with tin, to prevent it from dissolving either in the juice

juice of lemon or in vinegar, the two acids whose activity causes them to be most suspected.

Tin being more oxydable than lead, dissolves exclusively in these acids, and prevents the dissolution of the lead. The lead cannot take to itself an atom of oxygen, of which the tin will not immediately deprive it.

4. Lead, when it is alloyed with tin in equal parts or more, can never be dissolved before tin, which is always dissolved first; this same alloy taken internally and in a much stronger dose than is likely to be taken by a whole family, even when the tinned vessels in the house will last but eight days, is not in a state to have the slightest effect upon the health; besides there is not a single example to prove that it can.

5. It would not be more inconvenient to permit tinning to be made with one-third or a quarter of it lead, according to the ancient custom, rather than of fine tin, to accommodate it to the means of all classes; for in the housekeeping of poor families their stock of utensils are so much worn, that they cannot use them long without destroying them, and they are consequently obliged to have them frequently repaired, which becomes very expensive to them.

6. Every brazier who deceives as to the quality of the tinning that is bought of him is guilty of a fraud; which is very reprehensible, but not so much so as to justify the idea that he is the cause of death to many.

7. What has been said on tinning being applicable to pewter, to proscribe it without any other motive than a few vain fears, which no accident has yet justified, would be to deprive our arts and our houses of an alloy, which no other could replace, and which has been used in Europe from time immemorial; because its salubrity has never been even doubted. Such a prohibition would doubtless be little felt by the rich; but would it not

most

most cruelly abridge the few means that the poor have of furnishing themselves with kitchen utensils?

P. S. Since this memoir was presented to government, Don Domingo Fernandez and Don Antonio Cruz have been commissioned to decide, if acid beverages kept for some time in tinned vessels would dissolve the lead, and consequently become unwholesome.

These chymists selected from above a hundred sherbet vessels, which had been seized on the information of the pewterers, those which appeared to them to have most lead in them, and even those which were most injured by moisture; they suffered acid liquors of all kinds to remain in them for four days and four nights, and they afterwards submitted them to the strictest examination.

The result of their work, which they communicated to me, was, that vinegar, lemons, verjuice, cherries, gooseberries, sour milk, &c. absorbed no particles of lead that were appreciable by sulphate of potash, hydro-sulphureted water, hydro-sulphures, &c.

All these liquors took up a little of the tin, and some so little as not to be perceptible.

Experiments on some Combinations of Prussic Acid with Metals. By M. WUTTIG.

From GEHLEN'S CHEMICAL JOURNAL.

THE proper object of these experiments was to discover a method of obtaining pure prussic acid; on which account I have not examined these combinations in all their relations. As I attained my purpose, and these experiments presented to me also some other interesting phenomena, which were the more so, as these combinations have been hitherto but very little examined, I conceive them not unworthy of being laid before the public.

Prussiate

Prussiate of Zinc is obtained by saturating a solution of sulphate of zinc with prussiate of kali, or, in other words, by adding the latter to the former till no more precipitation takes place. The precipitate has, after being edulcorated and dried, a green colour, and is the desired product. If we expose it to dry distillation, it at first assumes a light brown colour, which gradually passes into a dark brown, and the prussic acid passes over from it entirely decomposed. The residuum contained in the retort, which has an empyreumatic smell, inflames when laid upon ignited coals, in contact with the air, and a white oxyd of zinc is left behind.

Prussiate of Tin. This combination is produced by mixing muriate of tin with prussiate of kali, in the liquid state. The prussiate of tin is precipitated, and exhibits, after edulcoration and drying, a light brown colour. In dry distillation, the prussic acid is expelled from it entirely decomposed; and if we conduct the gases which pass over into water wherein a quantity of muriate of iron is dissolved, the iron is precipitated. This seems to prove, that during the distillation caustic ammoniac is formed, which has united with the muriatic acid of the muriate of iron. In the neck of the retort, a small quantity of carbonate of ammoniac is deposited. The residuum is of a dark brown colour, has something of an empyreumatic odour, and does not inflame in the fire.

Prussiate of Copper. This combination is formed by adding prussiate of kali to a solution of sulphate of copper as long as a reddish-brown precipitate is formed, which is the prussiate of copper. The precipitate is edulcorated and dried. By dry distillation, even with the gentlest heat, the prussic acid is expelled from it decomposed, for the solutions of iron do not produce the slightest precipitate in water into which the gases which have

have passed over have been received. Here no ammoniac is formed during the distillation. When the residuum is put into the fire, its empyreumatic smell is exhaled, and the copper remains behind in an oxydated state.

Prussiate of Lead. This is obtained in the form of a yellowish-white precipitate, on mixing the solution of acetate of lead with prussiate of kali. If we subject the precipitate, after being edulcorated and dried, to distillation, there passes over, at a low degree of heat, first the greater part of the prussic acid undecomposed and perfectly pure; then, on increasing the heat, carbonate of ammonia is deposited, which proceeds from a portion of decomposed prussic acid, and a blueish-black mass is left in the retort. When I took this mass out of the retort, which had a strong smell of salt of hartshorn, (ammonia mixed with empyreumatic oil,) and laid it upon paper, it became heated and inflamed spontaneously, and that in a more lively manner than the ordinary pyrophores, which are formed by calcination of alum with charcoal, as the paper was also immediately set on fire. During the combustion an abundant disengagement of ammoniac took place, and the lead was left behind, reduced. As this phenomenon seemed remarkable to me, since no principle of those hitherto known was present that could be the cause of the formation of a pyrophore, I repeated the experiment, and that several times. I obtained, indeed, every time a mass of the same colour, and other properties, only I could never produce a proper pyrophore, but the mass, which was very highly inflammable, required always to be placed in a raised temperature, near to a candle or slightly ignited coals, before it inflamed and exhibited the other phenomena. Whether now, in order to obtain this product spontaneously inflammable, a certain moment of time is necessary, at which

the retort must be taken from the fire, or whether the extremely slow cooling (which I had accidentally employed the first time) is indispensably requisite for it, I cannot determine: so much, however, I have to remark, that in this spontaneous inflammation there was no fire near; nor do I know of the presence of any other substance which might have promoted the inflammation. I therefore leave it to others, who may take the trouble to examine, whether this easily-inflammable product is such to that degree as to inflame spontaneously.

When the residuum, which is obtained in the dry distillation of the prussiate of lead, is heated to redness in a crucible, an oxyd of lead, of a brick-red colour, is left behind, which under the continued action of the heat is vitrified. The inflammation of this residuum, under exposure to the air, is therefore necessary for the oxydation of the lead.

When the prussiate of lead is covered with water in a retort, and thus subjected to distillation, the water first passes over from it perfectly pure, then the prussic acid is disengaged from the lead entirely decomposed, carbonate of ammoniac is formed, and the residuum has the same properties as that obtained in the dry distillation. In this operation, therefore, the water must however have some effect upon the prussic acid of the prussiate of lead, whereby it is altered so that it cannot pass over undecomposed.

Prussiate of Silver. This combination is produced by mixing a solution of nitrate of silver with one of prussiate of kali. The prussiate of silver is thrown down in a greenish-white precipitate. By dry distillation of the edulcorated and dried precipitate, the prussic acid is separated in an entirely undecomposed state. In this operation no ammoniac is formed. The residuum, which becomes black during the treatment, has a somewhat empyreumatic

pyreumatic smell, which however does not differ much from that of the prussic acid. It is not inflammable; for when laid upon burning paper it extinguishes it.

It is necessary to remark, that for all these combinations the metallic salts were employed pure, and the prussiate of kali, which was used in all, was prepared from Prussian blue (freed, by means of sulphuric acid, from the admixture of alumine) with caustic kali.—I must farther observe, that in the preparation of these combinations we must not be too lavish in the addition of the prussiate of kali; for, in that case, with all of them, a part of the combination passes re-dissolved through the filtre. It will therefore be best to add rather an under-proportion of prussiate of kali, as we cannot easily hit the point of saturation with perfect accuracy. However, if we have already added too much of the latter, we may add to the liquid, which has been drawn off from the precipitate, still a small quantity of the metallic solutions, (whereby a precipitate is again produced,) then bring them again upon the filtre, and thus remedy the evil.

Of the above-mentioned prussiates, those of silver, lead, and tin, are decomposed by muriate of iron, but not those of copper and zinc. By the sulphate of iron none of these combinations is decomposed, although the contrary might have been expected, since the sulphuric acid is however generally admitted to have a greater affinity for metals than the muriatic acid.

From the experiments above described, it appears that the prussic acid is separated from each combination, decomposed or undecomposed, in a different manner. Whether this proceeds from the acid perhaps existing in a different state in each of these combinations, or whether one or the other metal assumes during the operation a different proportion of its ultimate constituent parts, remains still to be determined.

Finally, it results from all the experiments, that only two of these prussiates can be employed for obtaining pure prussic acid, namely, the prussiates of lead and of silver. As, however, from the first also a small portion of the prussic acid passes over decomposed, whilst from the prussiate of silver all the prussic acid, except a minute portion, which may almost be reckoned for nothing, is disengaged without decomposition, I can recommend this method to those who may have tried in vain to obtain prussic acid free from sulphuric acid or iron, as one whereby they cannot fail to accomplish their purpose.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Chemical Society.

IT has been observed, that those who cultivate any particular branch of Experimental Science are solicitous of associating with others engaged in similar studies; a common interest in the same subject of conversation excites a spirit of enquiry; thought gives rise to thought, and new ideas, collected in the friendly intercourse of society, often lead to investigations of the greatest importance. The student finds many difficulties removed which impede his progress by the ready information he obtains from men of higher acquirements, whilst those, who are skilled in chemical pursuits, frequently receive important observations from the mere lover of the science; to this may be added, that men, however great their learning or ardor may be for any particular branch of enquiry, yet, when deprived of the opportunity of communicating their ideas to others, not only become negligent and uninterested in improving the stock of knowledge

ledge they already possess, but are seldom solicitous about the further cultivation of their mental powers.

From a conviction of these truths, a number of gentlemen, who have a taste for Philosophical Chemistry, are determined to form themselves into a society, in which the talents of a number may be united, and become extensively useful to each other, by mutual communication of their views, their labours, and acquisitions. That their endeavour may prove as interesting as possible, particularly to those promoters of chemical science who cannot devote much time to the perusal of literary journals and periodical publications, arrangements will be made to collect, as speedily as possible, all the chemical news which issue from the Laboratories of other operators, both at home and on the Continent; and correspondences will be established to obtain the earliest and best information respecting whatever shall offer itself as new and important in the departments of Chemistry, of Natural Philosophy, and the Arts and Manufactures, which are dependent on these branches of knowledge. To keep pace with the existing state of chemical science, the intelligence thus collected shall be regularly detailed in their respective meetings; and a book of reference kept as a register, containing the growing mass of philosophical information, which will be laid on the table for the use of the members; together with all those publications and academical journals of repute, which exhibit the transactions of ingenious men in every part of the world.

The views of this society however will not be confined to the mere detail of literary intelligence and chemical conversations; a principal part of their labour will devolve to the practical department of the Laboratory. To accomplish this as perfectly as possible, all the interesting discoveries, which from time to time enrich the domain of Chemistry, and particularly those complicated, expen-

expensive, and difficult experiments, which can be repeated by few individuals only, shall be exhibited in their own Laboratory; being persuaded, that important experimental enquiries, when once witnessed, seldom fail to excite that degree of ardour which gives increasing energy to scientific research.

From this the Chemical Society will direct their attention to all such original and specific experiments, as may individually be proposed, and the results they afford shall be minuted in the journal of the Laboratory, kept for that purpose, and afterwards published in such a manner as may be directed. These enquiries will embrace whatever is deemed worthy of experimental research in the extensive departments of philosophical, practical, and technical chemistry. It is perhaps needless to state, that their Laboratory will be open for the analysis of ores, soils, manures, and such substances in general as are found in the British dominions, and are deemed of private or public importance.

And, as it is certain that the progress, as well as the accurate and extensive ideas, which the cultivators of Chemical Science may acquire, are greatly facilitated and promoted, by attending to the manipulations, and processes of the practical Chemist; it is likewise intended, that all the multifarious operations of the Laboratory, shall be regularly employed for obtaining from the crude materials of Nature, all those substances which the Society requires as instruments of research, or as specimens of truths, as well as those articles used in the Chemical Arts, and by Manufacturers and Artists. This part of the views of the Chemical Society will constitute a perpetual series of operations, well calculated to exhibit a summary exposition of all the general and particular processes of the scientific Laboratory: a consideration highly important to the progress of real improvement.

To

To give effect to this undertaking, a regular Laboratory is already fitted up, and an extensive collection of apparatus and instruments will be procured, to ensure those auxiliary advantages which are essential to the pursuit of the science.

Such are the outlines of the plan to which the views of the Chemical Society will be directed. A more particular detail of rules and proceedings would be premature and superfluous. It must nevertheless be remarked, that whatever encouragement the establishment may receive, the admission of Subscribers is for the present limited to Sixty, and the Annual Subscription fixed at Three Guineas.

An unlimited number of Gentlemen, residing in the country, may be admitted as Subscribers, on paying One Guinea Annually, which shall entitle them to visit the Society as Members, whenever they reside in the capital, provided their stay in town does not exceed three months.

After the first meeting the admission of Members shall be decided by ballot, and those who are not inclined to adopt the regulations then agreed upon by the majority of the Subscribers, shall have their subscription immediately returned.

A code of laws will be formed, and proper officers elected, so as to form a regular Society, which shall be denominated the London Chemical Society.

The admission of Members is for the present confined to a Committee, who, on the present occasion, address the Chemical Public, and request, that such Gentlemen as are desirous of becoming Subscribers may favour them with their names, for which purpose a book is opened at their Laboratory, N° 11, Old Compton Street, Soho.

List

List of Patents for Inventions, &c.

(Continued from Page 80.)

WILLIAM BUNDY, of Pratt Place, Camden Town, in the parish of Saint Pancras, in the county of Middlesex, Mathematical Instrument-maker; for machines or instruments for the purpose of making leaden bullets and other shot. Dated May 1, 1806.

STEPHEN HOOPER, of Walworth, in the county of Surrey, Gentleman; for an aqueduct, tunnel, or machine, for cleansing docks and other basins of penned water; and certain improvements on machines or machinery (for which he hath already obtained letters patent) for cleansing dry and other harbours, rivers, creeks, bars of harbours, and other purposes.
Dated May 3, 1806.

WILLIAM ROBERT WALE KING, of Kirby-street, in the parish of St. Andrew, Holborn, in the county of Middlesex, Tin-plate-worker; for a method of manufacturing tin, or iron plates covered with tin, commonly called tin-plates, into covers for dishes and plates.
Dated May 8, 1806.

MARTIN CAWOOD, of Leeds, in the county of York; for an improvement in the manufacturing metallic cocks, for conveying and stopping liquids.
Dated May 15, 1806.

RICHARD WILCOX, of the parish of St. Mary, Lambeth, in the county of Surrey, Mechanist; for improvements in steam-engines. Dated May 21, 1806.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LI. SECOND SERIES. August, 1806.

Specification of the Patent granted to BRACY CLARK, *of Giltspur-street, in the City of London, Veterinary Surgeon; for certain Improvements upon Horse Shoes.*

Dated March 25, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Bracy Clark do hereby declare, that the nature of my said invention, and in what manner the same is to be performed, is described in manner following; that is to say: Having discovered, by much attention to the subject, that in the present mode of shoeing horses, by nailing the foot perpetually to an inflexible iron shoe, besides the many calamities that the use of nails is subject to, the foot itself is injured in its properties, becoming stiff, hard and inelastic from being thus held for a long period without any motion whatever, or exertion of that elasticity which is natural to it; whence arises that tenderness of the feet which is so much complained of in the use of horses, and the danger of their falling; and which leads to the use of, or rather renders necessary, the sharp and painful bits in the

mouth, to divert the attention of the horse from the suffering of his feet: And having also satisfactorily proved, by actual experiments, that it is this constant nailing of the foot to the shoe which, by contracting and withering the foot, occasions the frog to be squeezed and pressed upon every side, and produces that foul and often painful disorder called the running thrush, and the consequent tenderness and danger this occasions. The operation of these causes renders it necessary annually to destroy thousands of these costly and useful animals prematurely, and before their age or bodily powers are at all impaired, being rendered unable longer to use their feet in any way that can be serviceable. Urged by these considerations, I have been led to attempt a new kind of shoeing altogether, by which those inconvenences will be entirely removed, and which, with much difficulty, labour and expense, I have at length happily effected. The useful property of the kind of shoe invented by me, is the great facility of its application to the horse's foot, and of its removal again, requiring only a few seconds, for this purpose, not exceeding in complication of its make, or difficulty of its application, the bits often used for horses' mouths, so that any intelligent person may easily apply them; and that they can be kept away from the foot whenever the horse is not at his work, or as often as may be desirable, leaving the foot at all other times to its perfect freedom, by which means the foot will be kept fresh, firm and free from disease to the latest period of life.

The specification of my invention, which admits of various modifications in the actual structure of it, is as follows. The shoe itself is made of two distinct parts, which can at any time be separated, *viz.* a shoe of elastic steel, or other metal, nicely fitted to the figure and turnings

ings of the foot, and sufficiently light in weight, with side and front clips or bands, as shall hereafter be described, by which it is held firmly to the foot. This shoe serves as a medium or means of attaching another shoe, called the wearing-shoe, to the foot, and which can be fixed to it or separated at pleasure. The wearing-shoe, or the under-shoe, which comes in contact with the ground, and receives the attrition and wear of the roads, is made of iron or steel, in the ordinary form of the horse-shoe, and can be renewed at pleasure when worn out, as it is merely screwed to the former by four or more sufficient screws in this way. The fitted shoe is made to last many years, or even in some cases the whole life of the horse.

The fitted shoe may be made of any metal, or mixture of metals, but steel seems the most suited to this purpose, or iron, or iron case-hardened, or silver made elastic, or steel or iron plated with other metals. This shoe is held to the hoof by stays or clips extending round the whole or part of the foot, which prevents the foot escaping laterally or in front; and these clips or holds are part of the shoe itself, or distinct and fastened to it, and are made with a slit or groove. The above fastenings, however, only prevent the escape of the foot in front or sideways, and it may be still subject to slide out backwards; and as the heels are elastic, tender, and sensible, no apparatus of the above kind can be used to prevent this occurrence, or severe compression of any kind; I have therefore, after much research and difficulty, devised another means of effectually preventing this inconvenience, by a bolt or bolts, or pin or screw, passing through or near the front or side clips into the hoof, and which are moveable with the growth of the hoof descending along with it; also on some occasions by bringing points through the

underside of the shoe upright into the hoof, to serve the same purpose; so that one or the other of these may be had recourse to, or both, as the ideas of security or fancy may suggest; or a band or bands of steel, or other metal, may be constructed to carry these points, or bolts, or screws, or plates, or hooks, or such like, and without the principle of this construction of shoe being at all departed from. These holes or excavations for lodging the bolts or points of steel are made in the hoof previously to their application with a small center-bit or gouge, or passer guarded, or other fit instrument, in such way as to prevent the possibility of its injuring the quick, and living parts beneath the hoof. A stout screw or toothed rack, or steel shaft, or other contrivance of this description, serves at the same time to carry these points, and to regulate their elevation and also descent along with the growth of the hoof: a sliding bolt and pin, or screw and nut, may also serve the same purpose, or other apparatus of this sort. The clips also may be placed on a single shoe of stout iron or steel, though a double one appears on the whole more advantageous, and numerous teeth may be employed to enter the hoof, and keep on the shoe, instead of one or more points or bolts; all these are only variations or rather modifications of the same general principle here laid down. The clips, the double shoe, and especially the bolts passing into the horn, are my discovery, and without which the thing cannot be usefully effected.

In witness whereof, &c.

Specification

Specification of the Patent granted to HENRY EDWARD WITHERBY, *of Islington, in the County of Middlesex, Gentleman; for an Apparatus for purifying and improving Water and other Liquors by Filtration.*

With a Plate.

Dated July 19, 1805.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Henry Edward Witherby do hereby declare, that the nature of my invention, and the manner of performing the same, consists in employing the process of filtration by means of an apparatus, by me contrived and invented, to remove the impurities of water and other liquors, thereby rendering the same more agreeable and useful for a great variety of purposes applicable to domestic occasions, and to sundry arts and manufactures. The manner of performance is by the said apparatus, which consists of two general parts; one of which I denominate the fountain, and the other, which includes a syphon, as below described, I call more peculiarly the filterer. The former supplies the liquor very gently and gradually as the filterer drains it off, without disturbing the sand, &c. through which it passes. The peculiar combination of these two parts constitute my invention. For I desire it may be distinctly observed, that I do not pretend to be the inventor of any of the articles specified below separately and apart from that combination thereof for the purpose of filtration, in which my invention consists.

First, *The Fountain.* A, Fig. 1, (Plate VII.) is a vessel to contain the water or other liquor to be filtered. B is a funnel, by which the vessel A is to be filled. Fig. 2 is the plan of a vessel having another vessel C, Fig. 3, about

about one inch deep, to fit into the top of it, as seen at C, Fig. 4, which is a section of the same vessel. DDDD are four supporters, to keep C, Fig. 3, in its place, so that its edge may be even with the edge of the vessel, Fig. 2, as may be seen in the section Fig. 4, at C. This part of the apparatus is so constructed, that when the vessel A, Fig. 1, is reversed, and placed on its legs, as it appears at Fig. 5, the pipe E of the vessel A dips into the vessel C, Fig. 4, about half an inch, and by that means forms the fountain. It is therefore necessary that the vessel A should be reversed and placed as it appears at A, Fig. 1, every time it is to be filled; and when filled put one of your fingers over the mouth of the pipe E; and having reversed it again, place it as it appears at A, Fig. 5, so that the pipe E may dip into the vessel C. When you remove your finger from the mouth of the pipe E, the water or other liquor descends into the vessel C, so as to fill it to the mouth of the pipe E, and very little higher, provided the vessel C be of a sufficient diameter to contain the water that descends into it. The mouth of the pipe E should have a notch in it, or else should be made so as to form a small angle with the surface of the water, in order that the air may pass more freely into the vessel A, whereby the necessary descent of the water will be facilitated.

Secondly, *The Filterer.* Fig. 2 is the plan of the vessel to contain the sand, &c. as hereafter described. It may be constructed of any size, either circular or square. The larger this vessel is the more expeditiously the filtration will be performed: it may be about six inches deep by a foot diameter. F is a small pipe in the bottom of the vessel Fig. 2, for the water to pass through. GGGG is a rim or cavity in the bottom of the vessel Fig. 2, similar to the hollow in a plate about an inch deep, and

the

an inch from the sides, as seen in the section Fig. 4, at G G. The hollow drain is to be performed by filling the whole of the cavity within the rim G G G G with well-washed pebble stones, or any thing that is clean, and not dissoluble; and at the same time easily pervious, so as to answer the purpose of making a hollow drain, as shewn in the section Fig. 4 by the part coloured red *. (Note. If instead of pebble stones hair-cloth should be used, care must be taken to have it of sufficient thickness, either in one piece or by several placed upon each other, to prevent the sand from passing through the pores or interstices of the hair-cloth; and this point being carefully attended to, the cavity G G G G above described, and also the flannel, will be the less necessary, or even may be entirely dispensed with.) Then cover the whole of the hollow drain with flannel cut exactly to the size of the top of the vessel Fig. 2, which is to be laid over the said drain, and will lap about an inch over G G G G (if used), as shewn in the section, Fig. 4, by the part coloured yellow †, which prevents the sand that is to be laid over the flannel from being washed through. The whole of the flannel is then to be covered with fine well-washed sand, as shewn in the section, Fig. 4, by the part coloured black, about two or three inches deep, or according to the depth of the vessel Fig. 2, so that there may be room for the vessel C to be placed on the top of the said vessel, Fig. 2, as before described. (Note. Fig. 2 is a plan, and Fig. 4 is a section, of the same vessel.) The vessel A, Fig. 1, is then to be filled and placed on its legs as it appears at Fig. 5, so that the pipe E may dip

* The colouring is necessarily omitted in the plate, but the part meant is that between G G.

† Exhibited in the plate by the white line or space also between G G.

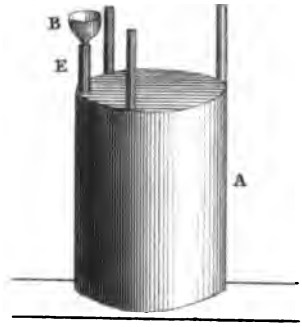
into

into the vessel C, as before described. The filterer and the fountain are then to be connected with the vessel C by applying a sufficient quantity of sponge or flannel, as seen at H, Fig. 4, which is to be cut into proper lengths, so that one end may be laid on the bottom of the vessel C, and the other end on the top of the sand in the vessel Fig. 2, as appears in the section, Fig. 4. This sponge or flannel acts as a syphon; and any other thing that will hold water, as a sponge or flannel does, and will act as a syphon, may be used for this purpose. Whatever the substance be, it is first to be filled with some of the water or other liquor to be filtered, and then applied.

Fig. 6 is drawn to have in part the appearance of glass, as seen at C and I, in order that the principle of the invention, and the effect thereof, may be the better understood; but it is not to be collected thence, that in practice and for actual use only one piece of sponge is to be employed by way of syphon, when a considerable quantity is to be filtrated. H is the syphon. The part coloured blue at K is to represent the water. H, acting as a syphon, keeps up a constant supply from the fountain at the vessel C, until the whole of the contents of the vessel A is filtered by passing through the sand as represented at L, and so through the hollow drain, formed as before described, (L, M, and N, being the sand, flannel, and pebbles,) and thence through the pipes, as represented at O, into the vessel that is to receive the water when filtered, as shewn at Fig. 7. There is to be a hole in the table upon which the apparatus stands, for the pipe of the vessel I to go through; but a more convenient method of fixing this apparatus would be, to have two shelves fixed against a wall, one under the other; the upper one to support the apparatus, and the lower

Fig. series.

Fig. 1.



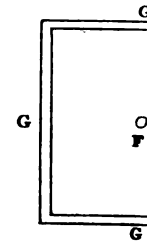
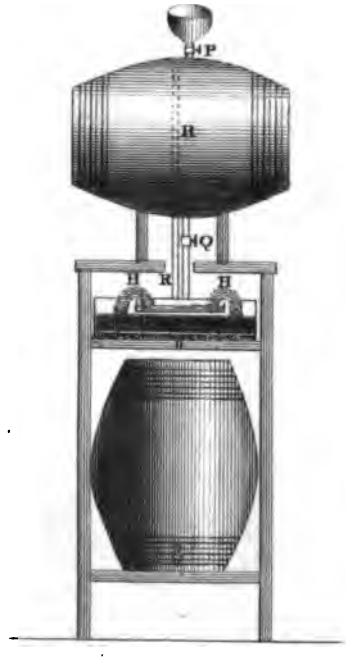


Fig. 8.



lower one for the vessel to stand upon to receive the water when filtered.

In constructing the filterer as above described at Figs. 2 and 3, I prefer earthen-ware. The vessel A may be constructed either of tin or earthen-ware; but as it is to be removed every time the vessel A is to be filled, I think it would be most adviseable to have it constructed of tin. But these are points to be left to discretion.

Fig. 8 is a representation of the apparatus in another shape, and on a larger scale; in which the parts that require explanation are the cocks P and Q, of which Q is to be shut and P opened when the barrel is to be filled with the liquor to be filtrated, and P is to be shut and Q opened when the liquor is to run off towards the filterer. R R is an air-pipe, passing up to near the top of the upper barrel in the inside, and reaching down to the surface of the liquor in the vessel C. By means of this pipe the air passes out of the barrel as the liquor comes in from the funnel; and after the barrel is sufficiently filled, there is through the said pipe a constant supply of air pressing upon the surface of the liquor, and forcing the same downwards from the upper barrel to the vessel C.

Fig. 9 is a plan of a vessel with the syphons, as before described at Fig. 4.

Fig. 10 is an apparatus slung upon chains, to shew how this invention is to be used in a convenient manner on board of ships. In the space marked S S the syphons and hollow drain, &c. are to be placed as in Fig. 8. One of the conveniences of this apparatus, is the great facility with which it may be cleansed from time to time, by squeezing and washing the sponges, or whatever else is made use of to act as syphons; and by removing the sand, &c. and supplying fresh materials of the same kind.

A principal advantage also is the dispatch with which the muddiest or most impure liquor may be made perfectly bright and clear. This may be effected very rapidly, and in a large running stream, in an apparatus upon an enlarged scale; and as the thickness of the liquor is a very little hindrance to the filtration, it may be useful in many cases to mix some suitable substances in the liquor intended to be purified, in order that such liquor may, by the adhesion with the substances so added, be the better, and more effectually cleared of its impurities.

In witness whereof, &c.

Specification of the Patent granted to JAMES INGRAM, *of Castle-street, in the City of Bristol, Grocer; for a Method of manufacturing Powder Sugar from Raw Sugar alone, and from Syrup of Sugar alone, and from the Mixture of Raw Sugar and Syrup of Sugar together.*

Dated November 26, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Ingram do hereby declare, that my said invention is described in manner following; that is to say:

First. My process for making powder sugar from raw sugar alone. Mix seven pounds, or thereabouts, of raw sugar with one pint of water, or thereabouts, or with one pint of lime-water, or thereabouts, of the same strength usual in refining lump sugar. Boil the sugar thus mixed in a metal kettle, or any other fit vessel; after it has boiled some time, dip the stem of a tobacco-pipe, or any other

other thing that will answer the purpose, into the sugar whilst boiling, and then put it in cold water; and when the sugar can be taken off from the pipe, &c. with the fingers with ease, and breaks brittle, it is a proof that it is sufficiently boiled. Pour the sugar out on a marble slab, polished stone, or any other thing that will answer the intended purpose, greased slightly with butter, lard, or any liquid of an oily and wholesome quality. Let it remain in this state about three minutes, and until it begins to harden. Then roll it together in two rolls or more if deemed necessary, and pull and draw each of the rolls with your hands repeatedly over an erect iron spike, or other proper thing, throwing it back over the spike every time, and pulling it forward until the sugar whitens and becomes stiff; then take the rolls off the spike, and leave them for six hours, or more if necessary; and when they are quite hard and firm put them into a stove to dry in the same manner as is usually adapted for drying lump sugars. Keep the rolls in the stove for two days or more if necessary, and when they are quite dry, take them out, and grind them in a sugar-mill with a large stone, or other proper thing, into a powder. Then sift the powder through a fine wire, or other proper sieve. Then return it to the mill, and mix it with bastard sugar, or raw sugar, in the proportion of fourteen pounds, or thereabouts, to each hundred weight of powder sugar, or thereabouts, to condition it in the usual way bastard sugar is conditioned; the powder sugar will be then fit for sale. To make any greater quantity than seven pounds of powder sugar at a time, every seven pounds of raw sugar, or thereabouts, will require a pint of water, or a pint of lime-water, or thereabouts, mixed with it; for instance, fourteen pounds, or thereabouts, of raw

sugar, will require two pints, or thereabouts; twenty-one pounds of raw sugar three pints, or thereabouts; and so in proportion for any greater quantity.

Second. My process for making powder sugar from syrup of sugar alone. Boil ten pounds of syrup of sugar, little more or less, in a metal kettle or other proper vessel; and after it has boiled some time prove its strength or firmness in the way mentioned above, and pursue the same directions as are before given in all respects, except as to the mixture of water, which is unnecessary.

Third. My process for making powder sugar from the mixture of raw sugar and syrup of sugar together. Mix three pounds and a half, or thereabouts, of raw sugar with three pounds and a half, or thereabouts, of syrup of sugar. Boil the sugar and syrup thus mixed in a metal kettle, or other proper vessel. The remainder of the process is the same as that first above specified, except as to the mixture of water or lime-water, which is unnecessary.

In witness whereof, &c.

Specification of the Patent granted to WILLIAM MILTON, *Vicar of Heckfield, in the County of Southampton, Master of Arts; for a Mode of rendering Carriages in general, but particularly Stage-Coaches, more safe than at present, and various other Improvements upon such Carriages.* Dated November 16, 1806.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Milton do hereby declare that the purpose of

of my said invention is to render all kinds of carriages, particularly stage-coaches, more safe and secure, by putting them more out of reach, than at present, of the mischiefs arising from the two most usual accidents, namely, overturning and breaking-down. The figure hereunto annexed will shew how both are meant to be done. The wheels (whether two, three, or four) on which a carriage ordinarily moves, I would call active wheels, for the sake of a distinction, which will be wanting. The drawing or figure is meant to represent a stage-coach. A B, Fig. 1, (Plate IX.) the body or carriage for inside passengers, and C D a box below it, capable of receiving the luggage of every journey, with its floor about ten, twelve, or more inches above the ground. This box may either be made single or with a division, and with one or more doors. By disposing the luggage in this box the centre of gravity of the coach and load is brought down so as to render an overturn much less likely than at present. Through either the carriage or the luggage-box let there be a hole or cavity seen at E; through which the main axle, (that which has no lock,) and any frame-work it may have, is to be passed. This cavity, and axle with or without frame-work, are to be such as shall give proper guidance in the play of the carriage and luggage-box on any springs that may be so applied as to want such guidance. But springs may be applied in such manner as to need no such guidance, but only room in the cavity for the play of the axle; for instance, where they are fixed on a frame or shafts, as they are seen in the figure, where S R is the perch-bolt. Where no springs are applied, this main axle will be fixedly passed through either the luggage-box or the carriage. At the bottom of this luggage-box, and as near respectively

tively to each active wheel as a workman may think proper, low strong idle wheels H H are to be placed on sufficient axles, ready, in case of an active wheel coming off or breaking, or an axletree failing, to catch the falling vehicle, and instantly to continue the previous velocity; whereby the mischief, particularly to the coachman and outside-passengers, arising from an instantaneous stop to rapid motion, will be prevented. These idle wheels are to be placed with their periphery a few inches below the floor of the luggage-box, and a few inches above the ground. If there be no luggage-box (in any carriage) below, then the idle wheels may be fixed to the axle, or to some frame-work belonging to it; and in case of a wheel coming off or breaking, great relief, as above, will be given. But if the axle breaks between its bearings, no relief will be given, unless the idle wheels be affixed to the bottom of a luggage-box; and, in this case, the nearer these idle wheels are to the ground, the more relief will be given, for the less will be the drop. If there be an obstacle in the road, and an idle wheel takes over it, its respective active wheel will for the time be discharged from the ground. The bottom of the luggage-box being so near the ground, offers a method of checking, very considerably, the motion of a carriage down a hill; by the strong and ready application, at pleasure, of the end of a lever (shod with iron, and fixed by a pin to the bottom of the luggage-box) to rub on the ground. The idle wheels should be fixed or set on in such a manner as that they may be vertical when an accident brings them into work. From the great variety in vehicles, in springs, and in their application, it will sometimes be requisite to put the idle wheels on the body or luggage-box of the carriage, and sometimes on any part

part or parts of the under-carriage, and sometimes on both; from the case before him any workman will determine.

In witness whereof, &c.

We have been requested by the Patentee to accompany the insertion of the preceding specification with the following certificate.

Hartford-Bridge, May 28, 1806.

At the request of the Rev. William Milton, of Heckfield, I take the liberty of hereby certifying to the public the truth of the following particulars:

A stage-coach, for six insides, having been constructed by Mr. Michael Bailey, of Hartley-row, on the principles of the plan, and pretty severely loaded, I put to it four of my own horses, having engaged Mr. Thomas Ward, of the Exeter line, (as experienced a coachman as any on the road,) to drive it a twelve-mile-stage, and to give it a full trial. The trial was made on Friday last, the 23d instant, from my door at Hartford-Bridge to Blackwater, and back again; and the following is the substance of Mr. Thomas Ward's report.

Overturning.— He soon found what he might venture; and he took it accordingly over such ground as would, most assuredly, have caused an overturn of any stage-coach with its usual load. This was repeatedly done in the presence of six insides and ten outsides, besides the coachman. Seven parts, perhaps, in ten of the load (which was nearly three tons) lay on the hind wheels: these, by the Patentee's direction, were six feet high, and with no dishing, and, as he deemed, sufficiently strong:

strong: they did not fail; but it was the opinion of Mr. Thomas Ward, and of all the practical men on the spot, that they were not such as could shew the principle of safety, as to dangerous and side-long ground, up to its full extent. As it was, however, any common coach would have gone over at fifty different places during the stage, which this coach took without the least symptom of overturning.

Breaking down.—A linch-pin of one of the hind wheels was then taken out; the coach went on, and presently off came the wheel, and down dropped the carriage, about seven inches, on a small strong idle wheel, which immediately continued the motion without the least inconvenience to the outside passengers, or puzzle to the horses; and the shock was not greater than what is produced by taking over a stone in the night; and if it had been required, the coach might have been taken five or six miles on by means of this idle wheel: and Mr. Thomas Ward very confidently thinks that *these two circumstances of safety* would invariably attend any stage-coach so constructed.

Loading.—Heavy packages help to make the safety of the plan: and these will be loaded and unloaded with greater readiness than at present.

It was to be expected, that, whoever was the builder, the first coach built on this new plan might go out with some faults: none, however, shewed themselves, but such as are obviously to be remedied.

It weighs eighteen hundred and a half.

Draught.—My horses ran their stage without more fatigue than usual; considering that the coach was frequently

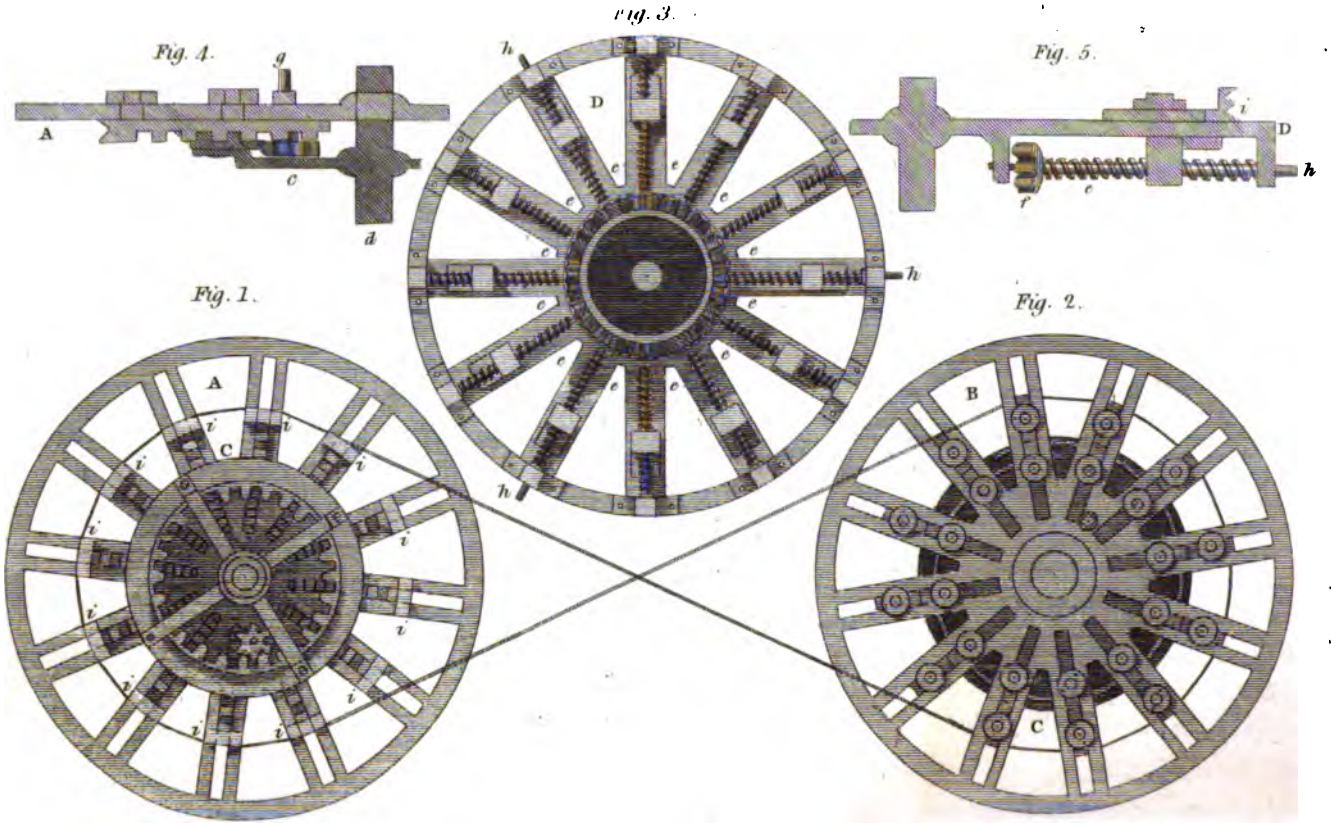


Fig. 3.
Fig. 4.
Fig. 5.
Fig. 1.
Fig. 2.
A
B
C
D
a
c
e
f
g
h
i

quently taken over much rougher ground than a turnpike, and with a heavier load than ordinary.

NICHOLAS DEMEZY.

We the undersigned, who have read with attention Mr. Demezy's certificate on Mr. Milton's coach, dated Hartford-Bridge, 28th of May last, and who are just returned from witnessing, in this neighbourhood, a repetition of the experiments upon it, give it as our opinion, that every circumstance regarding the coach has been correctly stated by Mr. Demezy; and we think it incumbent on us, under this impression, to add, that it concerns the safety of the public to procure its speedy adoption.

Reading, the 17th June, 1806.

John Stephens,
Thomas Stokes Salmon,
John Bulley,
Henry Boyle Deane,
Thomas Ring,
H. Marsh,
John Bulley, Jun.
J. E. Liebenrood,
R. Valpy,
Richard Richards,
J. Symonds Breedon,
Edward Barry,
Geo. Mitford,
Matthew Robinson,
J. Monck,
Christopher Hunter,
R. Westbrook,
J. Newbery,
John Blandy,
Samuel Hawkins,
John Deane,
T. Stubbs,
Thomas Cowslade,
Edward Skeate White,
Henry Symonds,
J. Taylor,
L. Austwick,
Francis Cowslade,
R. Richards, Jun.

On the Nature and Properties of Manures, and the Mode of preparing and applying them to various Soils. By ARTHUR YOUNG, *Esq. F. R. S.*

(Continued from Page 122.)

CHAPTER VII.

Of Yard and Stable Dung.

TO attempt exhausting such a subject as this would be to compose a volume. The time allowed by the Society can admit of no more than seizing the features which are most prominent.

Every writer with whose works I am acquainted, and at least ninety-nine farmers in one hundred, have written and practised on the common system and preconception, that dung is to be accumulated on hills or receptacles for a longer or shorter time, till fermentation and putrefaction have brought it, after few or many months, and few or many operations of turning or mixing, to a certain state, in which it is ready and proper for applying to the land.

But there is another system of management, which of late has attracted a good deal of attention, and that is, to use it fresh as made. Now if this method should by experiment be proved right, it renders nearly useless all elaborate dissertations, by which we are instructed in the whole management of dunghills; since the result would prove that we ought to have no dunghills at all, or nearly none.

As this question must necessarily influence whatever can now be ventured on the subject, I shall take the liberty of making it the first object of enquiry.

In the first place, let us search for facts and experience. The late Mr. Ducket conceived, that the more dunghills

dunghills are *stirred*, and turned over, and rotted, the more of their virtue was lost. Long dung he esteemed much more than the same quantity of short dung, which time had converted the former to *.

Mr. Patterson, of Wimbledon, agrees with many garden farmers near him, that on a comparison of fresh dung with such as is well mixed and rotten, the result is very generally in favour of the long †.

Mr. Bocket, of Hertfordshire, a very accurate farmer, says, the fresher dung is used, the better even for grass ‡. He has found long dung, of only one or two months old, to be better, load for load, than black spit dung for turnips.

The best farmers at Wintringham are of opinion, that laying yard dung on heaps is bad; it is much better to cart it to the land at once. Mr. Crust remarked, that those who make heaps, and consequently rot it much, never have such a return from their dung as others by a different management. Mr. Lloyd is much against hilling manure; always carrying it long from the yard: he has made repeated observations on the comparison, and is decided in the result. Mr. Clough leads dung directly from the yard; never hills it, which is utterly disproved of §.

Near Meaux, in France, the farmers carry out their dung quite in a long strawey state, which they contend earnestly is much better than to leave it to be more rotten ‖.

Mr. Johnson, near Northampton, has been for many years in the practice of carrying on to his land long straw

* Annals, vol. X. † Ibid. vol. XVII.

‡ Columella says, that the very freshest ought to be spread on meadows. Lib. ii.

§ Lincoln Report. ‖ Young's Travels.

dung, merely wetted by the cattle; and has found that the fresher it is laid on the land, the better the effect. He carries it out as fast as made; and if not done quick enough, observes a failure in the crop. He spreads such even on his grass in summer, and finds the effect great.

Mr. Robinson, near Salisbury, gives his own account. "I was long in the habit of drawing all my dung out of my yard, and laying it in a heap to be half rotted before I carted it to the ground; but by thus doing, when I pondered the subject over, I thought it not unlikely that I lost both in the quantity and the quality of the dung, and I was sure that I multiplied labour, and increased expense. To satisfy my doubts, therefore, I hauled the dung immediately from the yard to the field, where I meant to sow pease; and with a skim before the coulter buried this long stuff pretty well. I drilled the pease, and never hacked a better crop, or had a cleaner and mellower season for wheat. This trial removed my doubts, and I have since followed the same plan with advantage; and have the satisfaction of seeing many others, formerly equally blind with myself, sufficiently quick-sighted now to reduce their labour, and increase their crops. I have been confirmed in the practice by observing the conduct of a very able, wealthy, and experienced farmer near Chippenham. He has pasture, or dry meadow, arable, and down. He folds his arable, and dresses with the sweepings of the town, and leads all his long dung from his yards to his pasture grounds; and the greener the dung, the better he likes it. By persevering in this method, his crops of hay are doubled; and where cattle were never before attempted to be fattened, he now feeds oxen of two hundred stone for the Bath market *."

* Annals, vol. XXXVIII.

Mr.

Mr. Rogers, of Ardleigh, in Sussex, an extremely intelligent and successful farmer, has carried both long and short dung on for turnips, and for potatoes, and found the long best: and the experience has induced him to have much fewer muck hills than he formerly had. He carries so much directly to the land, that he has not one hill on his farm to ten that he had formerly *.

Mr. Chapman, of Hitchin, has observed, that about Baldock the farmers carry out their dung in a remarkably long state, without rotting, and yet they get as good turnips as any where.

Mr. Roberts, of Kings-Walden, would always, on every account, carry stable dung long and fresh to the land. But he thinks that farm-yard manure should be turned up once, yet not kept too long.

Mr. Shedgwick, of Rickmersworth, carries all his dung out for turnips, when he has finished his spring-sowing. He is clearly of opinion, that long dung is best; and if it could be carried from the stable, and ploughed in immediately, it would be by far the best †.

I have collected other modern authorities.

Mr. Denton, of Norfolk, manured one part of a field, a layer of seeds (the soil quite a sand) with fresh long dung, and the other part with turned-over short dung: the difference was considerable, and in favour of the long dung. Mr. Bradfield, of the same county, carries his yard-dung long, without any turning or mixing, and spreads it about six weeks before sowing turnips.

Mr. Priest, upon land unkind for turnips, laid long fresh dung in the furrows of narrow ridges, reversed them, and drilled; the crop the largest turnips, and the best in the neighbourhood.

* Annals, vol. XLI. † Herts Report.

When

When Mr. Everit has fallen short with his dunghills, and has taken long and fresh dung to finish with, he has had as good turnips as after the short.

Mr. Brown has carted long stable muck in March, for turnips, and had as good turnips as from short hilled muck; but gives fifteen loads instead of twelve.

Mr. Francis has tried long muck fresh from the yard, and it does as well as any; but not quite so quick a growth of turnips for the first six weeks.

Mr. Cubit has often carried out long fresh dung for turnips, and the effect has been very good, especially if the land has been at all strong or wet.

Mr. Dyble has on many acres carted long fresh stable muck for turnips, ploughing it in at once, and gained fine crops, if the season proved wet, but not in a dry time.

Mr. Repton thinks long dung the best for turnips; however, he seldom uses it; but when he has, the turnips have generally been the best.

Mr. Johnson, of Norfolk, thinks that muck wastes by keeping to an unprofitable degree; and that the more it is turned over the worse. He has tried long muck fresh from the yard for turnips, and got as good crops by it as by any other, and the corn also as good.

Mr. England, Mr. Reeve, and Mr. Dursgate, have tried both, and think short muck best for turnips.

Every one of the preceding list are excellent and truly practical farmers, to whom I applied for their opinion on this point, so far as it was founded on experience.

"With respect to laying on manure," says Mr. Wilkes, "I have experienced that dung carried from the stable-yard, at not more than three days old, and laid directly on the land, both in summer and in winter, has an advantage

vantage of 20 *per cent.* over that dung which is kept from nine to twelve months *."

"I use long muck from choice; which I think far better than turning, mixing, and rotting it †."

"I have the authority of one of our most intelligent and experienced farmers for asserting, that half-rotted litter is of more advantage than it would be if kept at the farm until thoroughly rotted ‡."

As the tendency of this system is to work almost an entire change in the rural œconomy of the larger part of the manure which is raised in most farms, I have been solicitous to multiply cases; and I think the Society will be of opinion, that this is a point which should be settled before any disquisitions on the management of dunghills should be offered. But it cannot be expected that the best-attested facts should become the established rules of practice, until they can be explained and confirmed by a sound and rational theory. These facts must therefore be brought to the test of chemistry.

In the writings of Hassenfratz I find this remark: "The management of Picardy farmers is highly advantageous in the continual transport of their dung to their lands, rather than leaving it to be exhausted in the farm-yard, in order to be carried out at a fixed period. By applying the dung quite fresh to the land, its first fermentation is employed in heating the soil; the little alkali which it contains, instead of being dissolved in the farm-yard, and carried off by rain, remains in the land, and improves it, if alkali be useful to vegetation. The straw yet entire better divides the soil; its fermentation advances less rapidly, is less advanced when the seed is

* Communications to the Board of Agriculture.

† Rudwell, ibid. ‡ Dr. Fenwick on Manures.

sown,

sown, and consequently the dung is in a better state for furnishing a great quantity of the chalky carbonic acid, which hitherto appears to be, with water, the principal aliment of plants." And in another work he has since declared his opinion, that carbon is the principal food; and water, I suppose, its vehicle. I need not remark to so enlightened a Society, that this gentleman is one of the greatest chemists at present in Europe, and that his doctrine meets the entire approbation of Mr. Kirwan.

A point of extreme importance is here implied, if not expressly asserted, that it is the same kind of fermentation which acts upon a small portion of moistened straw in the land which effects the conversion of a large mass in a dunghill. Nor is it easy to conceive the destruction of the one, but on the same principles which destroy the other.

Dr. Darwin asks a most interesting question. "If the recrements of vegetable and animal bodies, buried a few inches beneath the soil, undergo the same decomposition as when laid on heaps in farm-yards? Although this is accomplished more slowly, yet it is attended with less loss of carbonic acid, of volatile alkali, of hydrogen, and of the fluid matter of heat; all which are emitted in great quantity during the rapid fermentations of large heaps of manures, and are wasted in the atmosphere, or on unprolific ground." "By using dung in a less decomposed state, though it will require some time before it will be perfectly decomposed, and reduced to carbonic earths; yet it will in the end totally decay, and give the same quantity of nutriment to the roots, but more gradually applied *."

That fermentation of vegetable bodies, which is accelerated and enriched by the addition of animal matter,

* Darwin.

is

is an oxygenating process; the oxygen unites with the carbon and phosphorus in the decomposition of these substances. "When vegetable substances are decomposed by fermentation, there is a quick union of oxygen and carbon; and the carbonic acid gas rises in vapour," and is lost from a dunghill; "but in mould turned over and exposed to the atmosphere, this carbonic acid is slowly produced, and is absorbed by vegetable roots *."

"Vegetable and animal matters cannot serve as manures till they begin to ferment; nor are they of any utility when the fermentation is finished †."

"There is good reason to believe, from many facts, that putrefaction is no way necessary to the nutritive power of animal and vegetable matter, but in so far as it diminishes their cohesion, or destroys their texture, and thereby renders them fitter for absorption; and as there is a considerable waste in gasses and ammoniacal and nitrous salt by the putrefaction, it is of importance not to allow the putrefaction to take place at all where it is not required to break the texture ‡."

Without multiplying quotations, here is an ample fund provided by chemists of great eminence for the mind of an attentive reader to work upon. They are fully sufficient to account for the observations of the practical farmers inserted above. And this application of chemical to agricultural facts should make the farmer deeply reflect, before he continue a system of management in which much expense is exerted in order to do mischief.

He who is within the sphere of the scent of a dunghill smells that which his crop would have eaten, if he would have permitted it. Instead of manuring his land, he manures the atmosphere; and before his dunghill is

* Darwin. † Senebier.

‡ Dr. Pearson's Notes on Cullen.

finished turning, he has manured another parish, perhaps another county.

View all the farm-yards in the kingdom, and the management of the dung; in some it is better than in others; in some, water washes the manure away; in all the atmosphere perpetually depredates.

I shall add no more on this elucidation, but proceed to the practical division of the subject *thus considered.*

§ 1.—*Of the Nature of Dung.*

All organized bodies are resolvable into hydrogen, nitrogen, oxygen, carbon, phosphorus, and sulphur.

The mixture of animal and vegetable matter, which is called dung *per se*, or in union with water, earth, and the atmosphere, by nature or formation, contains all these. No wonder, therefore, that dung should be found an universal fertilizer.

§ 2.—*Of the Properties of Dung.*

The experiments are numerous, that give us reason to conclude, that the chief articles in the food of plants are hydrogen and carbon. The trials are satisfactory upon the first; but carbon is given in so many ways united to hydrogen, that it is not often easy to decide what is due to one substance, and what to the other. Some degree of uncertainty attends all applications by water; for if the plants decompose it, it may be the hydrogen they absorb, and the added substance may only assist in the decomposition.

The grand property of dung is therefore to yield immediate food to plants. It farther opens the soil, if strong; it attracts moisture; and, by the fermentation which it excites *in the soil*, promotes the decomposition of whatever vegetable particles may be already in the land. Its

effects

effects have powerful progressive influences; for the production of a great crop of leaf, root, and stalk, by its shade and fermentation, leaves the land in better order to produce succeeding crops. It would be useless to expatiate on properties so well known.

§ 3.—*Collecting.*

The circumstances to be attended to in the receptacles of yard and stable dung are few, but important.

The first object which I have attended to for many years, has been to spread a layer of earth over the surface of the yard; peat is the best for this purpose, with a portion of marle or chalk; in the want of this, turf, rich mould, scourings of ditches, and some marle or chalk; but not so much of either as to form so solid a bed as to prevent the penetration of the fluids, which should enter sufficiently to give a black colour to the whole. There is no necessity for removing this every time the dung is removed; as there are no advantages from fermentation in the mass till carried on to the land, no attention should be paid to prevent treading and pressing the mass. But as it is beneficial to have the whole as equal as possible, it is very useful that the stable-dung should be spread over the surface, and not left to accumulate at the door. The same observation is applicable to the riddance of the fat bullock-stalls and the hog-sties. Heavy rains will at times, in spite of every precaution, cause some water to run from the yard; this should be received into a reservoir covered, and by a pump raised on to heaps of earth prepared to receive it. This is all the attention necessary upon sound principles. In summer, weeds of every kind that do not propagate from the root should be early collected and spread over the surface, as well as leaves in autumn: and the foddering with straw, (if any,) and the

soiling on green food, should both be upon it, for all loose cattle.

§ 4.—*Preparation.*

None. No turning, or mixing, or stirring. But if circumstances of the richness, or quantity, or weather, have occasioned too much fermentation, or this is suspected, scatter every now and then a quantity of the same earth over the surface with which the yard was bedded, but not in layers. This may be so proportioned as to keep the mass from too much fermentation.

§ 5.—*The State in which applied.*

As it arises from the heap in such a strawey length as the time it has been accumulating will have permitted, a fermentation, more or less advanced, will have taken place from the mixture of vegetable matter with urine and dung, in proportion to the warmth of the season. Upon the principle just detailed, it is to be carried to the land as soon as circumstances of crops and convenience will permit. In a business of any extent this cannot be done exactly when the absorption of animal matter is enough to secure a due fermentation in the soil, but must be directed by other circumstances. The farmer is, however, not to lose sight of those principles which govern the operation.

§ 6.—*Application.*

This point demands attention. All dung should be applied to hoeing crops, to layers, or to grass land, and never to white corn; but this is more essential with fresh long dung than with that which is short. There will be many more seeds of weeds in it, several sorts of which are destroyed by a strong fermentation. To spread therefore long fresh dung on arable land, for crops not to be hoed, would be to sow the seeds of weeds without ensuring

suring their destruction. The proper crops for which to apply yard and stable dung, are turnips, cabbages, potatoes, beans, and tares for soiling; and the season for putting in these crops are the Spring, Midsummer, and September. But the farmer is not confined to carry on his dung at the time of sowing or planting: it is, on the contrary, much better (and especially with long dung) to have it previously deposited in the land. For turnips, and for cabbages planted in June, the manure may be given any time in April, May, or June; for potatoes, it may be laid in March or April; for tares, in Autumn or September; for beans in November; and ploughed in, ready for immediate planting or drilling early in the spring, without farther tillage. If the dung is turned in for any crop so early that more tillage is to be given before sowing or planting, it should be ploughed in deep enough for the successive operations to be shallow and above it. Never let it be forgotten, that all animal and vegetable manures have a constant tendency to *rise*, as fossil ones have to *sink*. By decomposition they come into a fluid state, and are either absorbed by the soil, taken up by the roots of the crop, or dissipated in the atmosphere.

Upon this system, therefore, the dung which is made in the depth of winter may be spread in March or April, for potatoes; the next made, and what is not wanted for potatoes, may be taken out in succession through April, May, and June, as convenience suits, for turnips and cabbages. That raised in July and August will be ready for tares; and what is produced in September, October, and part of November, is ready for beans. The best time for manuring grass is immediately after hay is cleared from the field. By this, or any similar application of the dung, the system of using long dung is rendered

dered consistent with the cultivation of the farm, and the convenience of the farmer.

It is proper to remark, that the use of the skim coulter is essential to ploughing in long dung. By means of this admirable addition to any common plough, every atom may be buried. To leave any of it sticking out of the furrows is to counteract the grand object of the husbandman, and materially to prevent that success which may be expected from the practice.

§ 7.—*Quantity.*

The right quantity of dung must be found from experiment. But at the beginning of any man's practice it will be proper to spread about the usual quantity applied in the old method. It has been found to answer in this proportion; and it is a circumstance extremely valuable, as it manures a much greater space of land than usual with the same stock of cattle.

§ 8.—*Soil.*

The idea of practical farmers is, that long dung is more applicable to strong than to light land; but Mr. Denton's experiment was on sand. Nor is there any reason, on an appeal to chemical principles, for fixing on any soil in preference to others for the application of this system of dunging. If, however, as it is generally allowed, it divides and loosens their constituent parts by its fermentation, it must necessarily have a more desirable effect on soils too compact, than on others already too light.

CHAPTER VIII.

Of the Sheep-Fold.

To examine the various circumstances of this method of manuring through the detail of sections would be tedious.

ous. There is scarcely a farmer in the kingdom that is not acquainted with the great benefit derived from folding. The immediate application of dung and urine to all soils, and of treading to loose ones, are so well known, that in some late discussions on the *profit* of the practice, no doubts that I am acquainted with have been expressed on this part of the question. It has rather been a discussion of live stock than of manuring. I shall only remark, that the case of the sheep-fold is a strong confirmation of the purport of the preceding chapter, so far as the animal part of yard-dung is concerned; for every one knows that sheep's urine and dung are so far from wanting fermentation previous to the application, that the sooner the seed is sown after folding, the greater is the effect *,

CHAPTER IX.

Of Pigeon's Dung.

This manure is esteemed by farmers to be *hot* and powerful, and is measured to the field by the bushel; the more common quantity is forty to fifty bushels *per* acre. If other sorts of dung were kept equally dry, they would not have the same effect, not equally abounding with volatile salts. It does not, in the house, run into those stages of fermentation which reduce a body to mucilage; and yet has, when spread, an extraordinary effect, affording one more reason for thinking that the common system of yard-dung is erroneous. Nor have I ever heard of any farmer throwing water upon it to promote fermentation.

* For a remarkable case of this, see Annals, vol. xvi. p. 354.

CHAPTER X.

Pond and River Mud.

There are few manures concerning which opinions vary more than upon mud cleased from ponds and rivers. In several registered experiments the benefit has been extremely great; in some others no good, or but little, resulted from it. Some farmers have found it very beneficial to mix lime with it. Some have, on experience, determined that it should be kept one or two years; and that it is much better for turning over and exposing thereby to the air. Others have carted it directly from the pond to the field with great success, neither adding lime nor stirring it. These different results are easily reconciled; for, in fact, no two ponds, or rivers, or parts of rivers, are exactly similar. In proportion as the water is resorted to by cattle, or water-fowl, or receives the washings of towns, houses, farm-yards, or privies, the mud must be good, and display its virtue in whatever manner managed. The quality of the water will have influence. The number of leaves that fall or blow into it will affect it. The natural soil of the sides and bottom creates a difference, whether it be calcareous, peaty, or clayey, &c.

When the circumstances are so numerous which may influence the quality of the mud, no wonder the observations made on its use should be contradictory.

A prudent farmer should examine the mud before he empties the pond; and he may do it with a certainty of discovering its quality and deficiencies. Let him dry a portion, and then fill some garden-pots, adding to some, chalk or lime in different quantities, and exposing some a longer and shorter time turned to the atmosphere. He may

may mix some with the soil of the field he intends it for, and have a pot of the soil only as a standard. This easy experiment is a sure way to discover, by the vegetation of the seeds he sows in the pots, the virtue of his mud. If he do not pursue this plan, let him analize the mud chemically, and discover whether it be calcareous or ferruginous, or impregnated with any other acid. By means of such easy trials he may proceed safely, and incur no expense that will not answer. I have emptied near a dozen ponds, and some of them large. I have formed composts of the mud, and also carted it immediately to the fields; and there was not more than two in which I doubted whether the manure answered the expense: in general it paid well, but in no case very considerably.

TO BE CONTINUED IN OUR NEXT.

Description of an expanding Band-Wheel to regulate the Velocity of Machinery.

Invented by Mr. ANDREW FLINT.

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Fifty Guineas were voted by the Society for this Invention.

IN the usual method of connecting machinery, by a band running over two wheels or riggers, it is obvious that the relative velocity of the wheels is in the inverse ratio of their diameters; and these diameters always remaining the same, no alteration of the velocity can be obtained, but by a corresponding variation in that of the moving power applied.

To enable the artizan to regulate the velocity of his machinery at pleasure, the moving power remaining as

before, or to retain the same motion, with an alteration in that of the applied force, is the purpose of the invention, the models of which are now laid before the Society. In this model are shewn two methods of attaining this desirable object; in both the periphery of the band-wheel is divided into any convenient number of parts, according to the size of the wheels, (in this case twelve,) which may be placed at any given distance from the centre of the wheel, (within the limits of the machinery,) and thus, by enlarging the circumference of one band-wheel, while the other is equally diminished, to alter the relative velocity of each at will. These parts of the periphery, which I term V's, and are marked by the letters *iiiii*, &c. are confined to move in grooves, cut in the large wheels A and B, Figs. 1 and 2, (Plate IX.) in the direction of their radii; and are moved by a spiral thread in the small wheel C, which thread takes in the teeth of the racks on which the V's are fixed. A part of the shaft on which the wheel A is fixed is made circular, to admit the small wheel C to turn round independently of the other, and thus to extend or contract the racks and V's in Fig. 3. Fig. 4 is a section of part of the rigger, in which the letters refer to the same parts as in Figs. 1 and 2.

In the wheel D the same effect is produced by the screws *e e*, &c. which are made alternately right and left-handed, and turn with equal motions, by means of the equal bevil-wheels *f f*, &c. fixed at their ends near the axis of the wheel. Fig. 5 is a section of the same.

The wheel C, Figs. 1 and 2, is moved round the shaft *d* by the pinion *g*, on the axis of which is fitted occasionally a winch. The screws of the wheel D, Fig. 3, may be also turned, by means of a winch applied to their projecting heads *h h h*. It is proper to notice that the number of the screws must always be equal.

Description

Description of a Machine for cutting Paper and the Edges of Books. Invented by Mr. J. I. HAWKINS, *of Dalby Terrace, City Road.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was presented to Mr. HAWKINS *for this Invention.*

THE object of this improvement is, to cut the edges of books on three sides at one fixing in the press: to do this, it is necessary that the book be placed at one end, and a support given to the plough beyond the part cut; there is therefore at each corner a block, moveable on a centre, so as to elongate alternately the side or end of the press.

The press is as wide as the intended length of the book.

At a distance from the end of the press, equal to the required width of the book, is a stop, made somewhat like two combs, one fastened on each side, the teeth of one going into the interstices of the other, so that it may effectually prevent the book falling too low, whether the press is open little or much.

In the common press the book is put in the middle, and there is a screw at each end to force the press together; but in this press, the book being put at one end, there is a screw about the middle, to force the press together, and another screw at the lower end to force it open, and consequently press the book tighter, exactly on the principles of cabinet-makers hand-screws.

REFERENCES to Plate VIII. Figs. 2, 3, 4, and 5.

Figs. 2 and 3, two geometrical views of the press.

Figs. 4 and 5, two perspective views of the same, as placed on its supports in the box which receives the cuttings. The side of the box is represented as taken away, in order to shew the parts more distinctly. Fig. 4 shews the position of the press when the front of the book is to be cut, and Fig. 5 while the ends are cutting.

N. B. The letters of reference are the same in all the figures. A, the press. *a*, the cutting-box. *b b*, the elongating blocks turning on their centres *(c)*. *d*, the screw which forces the press together. *e*, the screw which forces the lower ends of the press asunder, and consequently presses the book tighter. *f*, a piece of board put into the press with the book, to keep it firm against the knife. *g*, the comb-like stop. *h h*, bars fixed across the cutting-box, to support the press while the top or bottom of the book is cut. *i i*, bars to support the press while the front of the book is cut. In this position there is a bar (K) to keep the press steady, which is taken out when the position Fig. 5 is in use. *l l*, pieces of board, with notches in them, fastened to the box, to receive the bars. *m*, groove for the plough to work in.

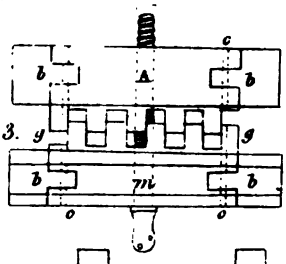
It is evident, from the positions of the press, that the plough must be worked on an inclined plane; but this, instead of an objection, is a considerable advantage, because the workman has much more power in that direction than on a level.

The press requiring to be turned round to cut the top and bottom of the book, the plough must be worked left as well as right handed, but this is acquired by a few minutes practice.

The same plough is used as with the common press.

Chemical

Fig. 3.



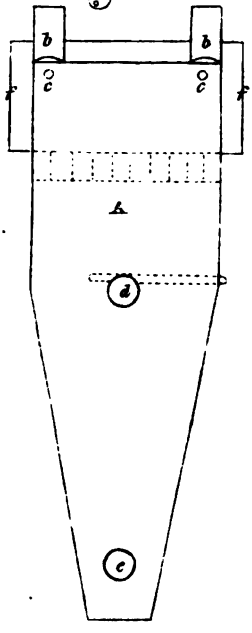


Fig. 2.

Fig. 4.

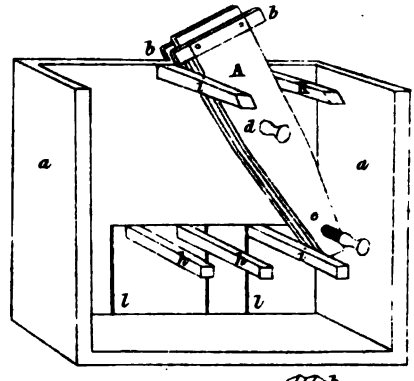


Fig. 5.

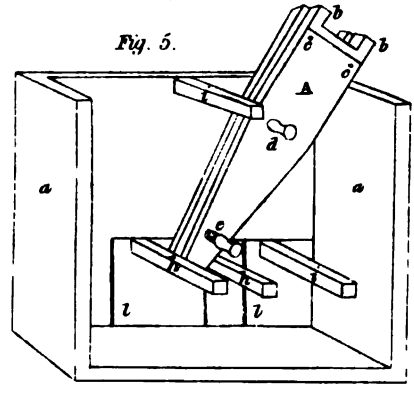
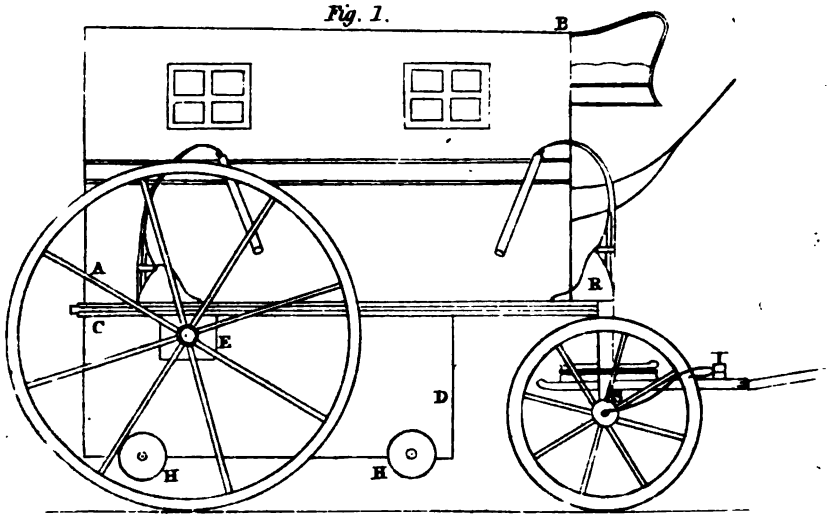


Fig. 1.



Chemical Experiments on Guaiacum.

By Mr. WILLIAM BRANDE.

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY.

AMONG the numerous substances which are comprehended under the name of resins, there is perhaps no one which possesses so many curious properties as that now under consideration; and it is remarkable that no more attention has been paid to the subject, since many of the alterations which it undergoes when treated with different solvents have been mentioned by various authors.

§ I.

Guaiacum has a green hue externally; is in some degree transparent; and breaks with a vitreous fracture.

When pulverised it is of a grey colour, but gradually becomes greenish on exposure to air.

It melts when heated, and diffuses at the same time a pungent aromatic odour.

It has when in powder a pleasant balsamic smell, but scarcely any taste, although when swallowed it excites a very powerful burning sensation in the throat.

Its specific gravity is 1.2289.

§ II.

1. When pulverised guaiacum is digested in a moderate heat with distilled water, an opaque solution is formed, which becomes clear on passing the whole through a filter.

The filtrated liquor is of a greenish-brown colour; it is of a peculiar smell, and a sweetish taste.

It leaves on evaporation a brown substance, which is soluble in alcohol, nearly soluble in boiling water, and very little acted upon by sulphuric ether.

This

This solution was examined by the following re-agents.

Muriate of alumina occasioned a brown insoluble precipitate after some hours had elapsed.

Muriate of tin formed a brown flaky precipitate under the same circumstances.

Nitrate of silver gave a copious brown precipitate.

Suspecting the presence of lime in the solution, I added a few drops of oxalate of ammonia, when the liquid immediately became turbid, and deposited brown flakes, which, after having been treated with boiling alcohol, yielded traces of oxalate of lime.

These effects, therefore, indicate the presence of a substance in guaiacum, which possesses the properties of extract*; the action of the reagent is however somewhat modified, by a small quantity of lime which is also in solution.

One hundred grains of guaiacum yielded about nine grains of this impure extractive matter.

2. Alcohol dissolves guaiacum with facility, leaving some extraneous matter, which generally amounts to about *5 per cent.*

This solution is of a deep brown colour; the addition of water separates the resin, forming a milky fluid which passes the filter.

Acids produce the following changes.

A. Muriatic acid throws down an ash-coloured precipitate, which is not re-dissolved by heating the mixture. In this case the resin appears but little altered.

B. Liquid oxy-muriatic acid when poured into this solution, forms a precipitate of a very beautiful pale-blue colour, which may be preserved unaltered.

* By the term extract, I mean that substance, which by chemists is called the Extractive Principle of Vegetables. Vide Thomson's Syst. of Chemistry, 2d edit. Vol. IV. p. 276.

C.

C. Sulphuric acid, when not added in too large a quantity, separates the resin of a pale-green colour.

D. Acetic acid does not form any precipitate. This acid is indeed capable of dissolving most of the resins.

E. Nitric acid diluted with one-fourth of its weight of water, causes no precipitate till after the period of some hours. The liquid at first assumes a green colour, and if water be added at this period, a green precipitate may be obtained; the green colour soon changes to blue, (when by the same means a blue precipitate may be obtained;) it then becomes brown, and a brown precipitate spontaneously makes its appearance, the properties of which will be afterwards mentioned.

The changes of colour produced by nitric and oxy-muriatic acids, in the alcoholic solution, are very remarkable, and I believe peculiar to guaiacum: there is moreover much reason to suppose that the above alterations in colour are occasioned by oxygen*. It likewise

* The following experiments appear to verify this supposition:

Fifty grains of freshly pulverised guaiacum were introduced into a glass jar containing 60 cubic inches of oxy-muriatic acid gas. The resin speedily assumed a brown colour, having passed through several shades of green and blue. Liquid ammonia was poured on this brown substance, while yet immersed in the acid; the whole became green; it therefore seemed thus to be deprived of part of the oxygen which it apparently had acquired by the preceding experiment. An equal portion of the same guaiacum was exposed, under similar circumstances, to the action of oxy-muriatic acid, excepting that the glass in which the experiment was made was covered with a black varnish, and placed in a dark apartment. On examining the result of this experiment, the resin was found to have undergone precisely the same changes as when exposed to light. Ammonia had also the same effect.

Guaiacum was also exposed over mercury to oxygen gas; the resin assumed after some days the green colour which a longer exposure to the atmosphere produces: this change was likewise found by a second experiment to be effected without the presence of light.

appears

appears from that which has been stated, that the blue and green oxyds (if they may be so called by way of distinction) are soluble in the mixture of nitric acid and alcohol, while the brown precipitate is insoluble.

F. Alkalies do not form any precipitate when added to the solution of guaicum in alcohol.

3. Gnaiacum is less soluble in sulphuric ether than in alcohol; the properties of this solution nearly coincide with those just mentioned.

4. Muriatic acid dissolves a small portion of guaiacum, the solution assuming a deep brown colour; but, if heat be applied, the resin melts into a blackish mass, preventing any farther action from taking place.

5. Sulphuric acid forms with guaiacum a deep-red liquid, which, when fresh prepared, deposits a lilac-coloured precipitate on the addition of water; a precipitate also is formed by the alkalies. If heat be employed in forming the solution, the resin is speedily decomposed; and if the whole of the acid be evaporated, there remains a black coaly substance, together with some sulphate of lime.

6. Nitric acid appears to exert a more powerful action on guaiacum than on any of the resinous bodies.

100 grains of pure guaiacum previously reduced to powder, were cautiously added to two ounces of nitric acid, of the specific gravity of 1.39. The resin at first assumed a dark green colour, a violent effervescence was produced, attended with the emission of much nitrous gas, and the whole was dissolved without the assistance of heat, which is not the case with the resins in general, for when these bodies are thus treated with nitric acid, they are commonly converted into an orange-coloured mass.

The solution thus formed yielded, while recent, a brown precipitate with alkalies, which was redissolved on the application of heat, forming a deep brown liquid.

Muriatic

Muriatic acid also separated the guaiacum from this solution, not however without having undergone some change.

Sulphuric acid caused no precipitate.

After this solution of guaiacum in nitric acid had remained undisturbed for some hours, a considerable proportion of crystallized oxalic acid was deposited.

When guaiacum was treated with dilute nitric acid, the results were somewhat different. A slight effervescence took place, and part of the resin was dissolved, the remainder being converted into a brown substance, resembling the precipitate obtained from the alcoholic solution as abovementioned. (*E.*)

This brown substance appears to be guaiacum, the properties of which are materially altered by its combination with oxygen; and I am led to think that the changes of colour produced by nitric and oxy-muriatic acids, are the consequences of the different proportions of oxygen with which the guaiacum has been united; for we know that the colours of metallic, and many other bodies, are greatly influenced by the same cause.

The brown substance was separated by filtration; the filtrated liquor yielded yellow flocculent precipitates with the alkalies, and on examination was found to hold nitrate of lime in solution.

The undissolved portion was of a deep chocolate-brown colour. A similar substance may also be obtained, by evaporating the recent nitric solution to dryness, taking care not to apply too much heat towards the end of the process.

The substance obtained by either of these means, possesses the properties of a resin in greater perfection than guaiacum; it is equally soluble in alcohol and sulphuric ether, insoluble in water, &c.; but when burned it emits,

a peculiar smell, more resembling animal than vegetable bodies. If, however, fresh portions of nitric acid be added three or four times successively, or if a larger quantity be employed to form the solution, the product obtained by evaporation is then of a very different nature; for it has lost all the characteristic properties of a resin, having become equally soluble in water and alcohol; the solution of it in this state having an astringent bitter taste *.

7. Guaiacum is copiously soluble in the pure and carbonated alkalis, forming greenish-brown liquids.

Two ounces of a saturated solution of caustic potash took up rather more than 65 grains of the resin; the same quantity of liquid ammonia dissolved only 25 grains.

Nitric acid formed in these solutions a deep brown precipitate, the shades of which varied according to the quantity of acid which had been employed.

This precipitate was found on examination to possess the properties of that formed by nitric acid in the solution of guaiacum (2. E.) in alcohol.

Dilute sulphuric acid, when poured into any of the above alkaline solutions, formed a flesh-coloured curdy precipitate. Muriatic acid produced the same effect.

The two last-mentioned precipitates differ from guaiacum, in being less acted upon by sulphuric ether and more soluble in boiling water; their properties therefore approach nearer to extract. Moreover, when these precipitates were re-dissolved in ammonia, and were again separated by muriatic acid, the above-mentioned properties became more evident.

* Vide Mr. Hatchett's two Papers on an artificial Substance which possesses the principal characteristic Properties of Tannin. Phil. Trans. 1805, p. 211 and 285.

§ III.

§ III.

100 grains of very pure guaiacum in powder were put into a glass retort, to which the usual apparatus was adapted. The distillation was gradually performed on an open fire, until the bottom of the retort became red hot.

The following products were obtained:

	Grains.
Acidulated water - - - - - - - - -	5.5
Thick brown oil, becoming turbid on cooling - - - - - - - - - - - -	24.5
Thin empyreumatic oil - - - - - -	30.0
Coal remaining in the retort - - - -	30.5
Mixed gases, consisting chiefly of carbonic acid and carbonated hydrogen - - -	9.0
	99.5

The coal, amounting to 30.5 grains, yielded on incineration three grains of lime. To discover whether any fixed alkali was present, 200 grains of the purest guaiacum (that in drops) were reduced to ashes; these were dissolved in muriatic acid, and precipitated by ammonia; the whole was then filtrated, and the clear liquor evaporated to dryness, but not any trace of a neutral salt with a basis of fixed alkali was perceptible.

§ IV.

From the action of different solvents on guaiacum, it appears, that although this substance possesses many properties in common with resinous bodies, it nevertheless differs from them in the following particulars:

1. By affording a portion of vegetable extract.

Does the oxyd of manganese effect the complete separation of the sulphur from sulphuretted barytes? And how does it effect this?

I thought that the answer to these questions would throw sufficient light on this subject.

A. According to the process which I have described in the above journal, I prepared a sufficient quantity of sulphuretted barytes, by melting in a quick furnace-fire a mixture of two pounds of heavy spar, with one pound of common salt, and four ounces of charcoal; with these proportions I had two pounds produced without that which remained attached to the crucible. A pound and three quarters require twenty pounds of water to hold it in solution at a mean temperature. In the solution first obtained, by boiling the pulverized mass for two hours with eight pounds of distilled water, in a tubulated retort, there was formed at the bottom of the vessel, in the transparent fluid, during 24 hours which were given it to allow the separation of the parts not dissolved, a great quantity of regular crystals; which, as far as I was able to observe, were small pyramids with four rhomboidal sides, which, on examination, proved to be hydrothionate of barytes*.

Eight pounds of distilled water were again poured upon the part not dissolved, and proceeded with as before.

By rest and cooling, a considerable quantity of crystals were again formed, such as those already obtained; but four pounds more of water added, with the same process as before, held them in solution in a mean temperature. The residue not dissolved, which was obtained by filtering all the solutions, weighed when dry one ounce seven grains, and consisted of charcoal, heavy spar not

* The German chemists give the name of hydrothion to sulphurated hydrogene.

decomposed,

is well known that by digesting mastich in alcohol, a partial solution only is formed, and there remains an elastic substance, which is generally said to possess the properties of pure caoutchouc; it appears, however, to differ from this substance in becoming hard when dried by exposure to air. Moreover, I have remarked that the part of mastich which remains dissolved by alcohol, may be again precipitated by water, and, on examination, I found the precipitate to possess the properties of a pure resin: but when a stream of oxy-muriatic acid gas was made to pass through the solution, a tough elastic substance was thrown down, which became brittle when dried, and was soluble in boiling alcohol, but separated again as the solution cooled: its properties, therefore, somewhat approached to those of the original insoluble part.

Experiments on the Process published by M. Dizé, *to decompose Sulphuret of Barytes by the Oxyd of Manganese.*

From Neues Algemeines Journal de Chemie.

M. VAN-MONS speaks in a letter addressed to M. Gehlen, (editor of the Journal de Chimie,) of a memoir of M. Dizé on the decomposition of alkaline sulphurets by the oxyds of lead and manganese, particularly noticing the decomposition of sulphuretted barytes by the oxyd of manganese. These observations appeared to me so important, not only on account of the experiments themselves, but also in regard to the theory of the particular phenomena of this decomposition, described by M. Dizé, that I resolved to ascertain their accuracy by experiments of my own.

Does

of oxyd of manganese was capable of desulphuretting, twenty ounces of the yellow solution was again poured on the residue, after the clear liquor had been decanted. By stirring it frequently, in about three days it also became desulphuretted as before. But a fourth portion stirred constantly for three hours, then left for three days and often stirred, was desulphuretted with difficulty. After having washed off the saline parts, the dry residue weighed five ounces and a quarter; the colour was of a blackish brown, and it contained several sharp crystals. It was marked No. 1, and put aside for farther experiments. This experiment having convinced me of the accuracy of M. Dizé's observations, relating to the separation of the sulphur, instructing me at the same time of the relative quantity of oxyd of manganese that must be used, I thought it necessary to find out by other experiments if the desulphuration could not be effected in less time.

D. With this view, twenty ounces of the solution were stirred for three hours with one ounce of oxyd of manganese, reduced to a very fine powder: but the separation of the sulphur was not entirely effected in this space of time; and it was not till after it had been stirred for two hours longer, that the desulphuration was completed, and the liquor clear like water. The residue washed and dried weighed nine drams, was of a dark grey approaching to brown, and likewise contained a few crystals. This was likewise put aside for future experiments, and marked No. 2. It now remained to be ascertained, whether in heating the mixture, before it is disturbed, it would hasten the separation of the sulphur from the sulphuretted barytes in a close vessel.

E. Twenty ounces of the same solution were in consequence heated till it boiled, with one ounce of oxyd of manganese

manganese in a very long-necked matrass, and afterwards stirred till it began to cool. After that the mixture was heated and stirred again constantly for three hours, in the same manner.

This process effected the separation of the sulphur, and the liquor became clear like water. It was then left to cool and settle; and 18 hours after, there appeared attached to the sides of the matrass a considerable quantity of small crystals, brilliant and brittle. The residue separated from the liquor by filtering, was dried; in this state they weighed six grains, and presented a collection of small needle-like and brilliant crystals upon a mass of dark brown, and easily pulverized. It was marked No. 3, and put aside, as the others were, to be re-examined; the liquor had only a slight taste of barytes, such as I had already observed in the preceding liquors, but not in the same degree. This astonishing phenomenon made me presume that a portion of barytes might possibly be combined with the sulphuric acid, or the sulphureous acid which would be formed; I thought I should discover this by the examination of the residues already mentioned.

F. The residue No. 1, thrown on hot coals or put into a red-hot crucible, burnt with a blue flame, accompanied with a smell of sulphur. Part of it put in contact with the sulphuric acid pure and perfect, disengaged no sulphuretted hydrogene gas, either with or without water, but sulphureous acid in the latter case. From the result of these two experiments, I concluded that the sulphur was not chemically united with the oxyd of manganese, but only in a slight manner, and that this combination ought not to be regarded as a true metallic sulphuret. To confirm this opinion, a dram of the sulphuretted residue was heated in a sand-bath, in a small glass vessel with a long neck, stopped with stenting. Pure sulphur was sub-

 limed,

[illegible] before the crucible was red: as soon as the heat was augmented in order to expel it, sulphureous acid was disengaged. The residue, which had lost ten grains in the fire, was by water reduced to a clear liquor; then mixed with pure sulphuric acid; and a great quantity of sulphuretted hydrogene gas was then disengaged with violence.

The sulphuretted manganese wetted with sulphuric acid, developed, as I have related above, sulphureous acid instead of sulphuretted hydrogene gas, which still was present after the same mixture had been heated to separate the sulphur. It was therefore to be presumed that this result proceeded from a portion of sulphurate of barytes contained in the residue. To ascertain this, the rest of the residue No. 1, was pulverized, mixed with two pounds of distilled water, and kept boiling half an hour, during which it diffused a strong smell of heated sulphur; the liquor after settling a little was decanted, and filtered while hot; the residue was treated as before, [illegible] two pounds of water, and the decoction being filtered was poured with the former, and both put aside to [illegible] at the end of 18 hours, there appeared a considerable [illegible] of white needle-like crystals, their insipidity, [illegible] disagreeable developement of a sulphureous acid by [illegible] same with sulphuric acid, and the formation of [illegible] proved it to be a true sulphite of barytes, [illegible] was also contained in a great quantity in the water [illegible] the crystals were taken. The residue obtained [illegible] weighed, when dry, five ounces, and retained [illegible] colour as before; it did not give with the sul[illegible] any indication of sulphuretted hydrogene gas, but [illegible] of sulphureous acid; yet, after the separation [illegible] of the sulphur by heat, the first was disengaged abundantly. It had therefore undergone no

change

change except that the boiling water had separated a little sulphite of barytes from it.

G. The residue No. 2, burnt upon hot coals, or in a red-hot crucible, with a blue flame and a smell of sulphur. A dram of the residue, heated in a long matrass, gave six grains of pure yellow sulphur; after which, it being kept heated, sulphureous acid was disengaged; the residue, which was of a blackish brown grey, and ten grains lighter, having been bathed in pure sulphuric acid a little diluted, disengaged hydrogene gas in abundance; which circumstance did not take place before it was heated. When boiled with water, it produced the smell of sulphur mentioned in the preceding article. The decoction filtered deposited also, when cooled, small crystals, which had the characters of sulphite of barytes; the residue of the decoction was such as had been produced by the same operation (letter F.) The residue No. 2, is consequently the same as residue No. 1, as to its state and composition: they both contain sulphite of barytes, sulphuret of manganese with an excess of sulphur, and probably also a little oxyd of manganese unchanged.

H. The residue No. 3, thrown upon hot coals or heated in a crucible, did not inflame either in one way or another, and diffused no smell of sulphur. A dram of the same residue, heated in a long close glass, disengaged sulphureous acid, but not an atom of sulphur. The residue, which still weighed 55 grains, having been heated with sulphuric acid perfectly pure, did not give more sulphuretted hydrogene gas before it was heated to a white heat, nor even of sulphureous acid, though the latter was disengaged from the same mass, treated with the sulphuric acid before it became red, in a much greater degree than the residues 1 and 2. The rest of the residue No. 3 was boiled in the proportion of half an ounce to

12 ounces of distilled water, letting it rest for half an hour; during this time it manifested a very trifling smell, scarcely to be perceived, of heated sulphur; after a little rest, the liquor was filtered while yet warm, and the residue was collected on the filter and dried. In this state it weighed three half-drams, and had still the same colour as before. Treated with pure sulphuric acid, it developed no more sulphuretted hydrogene gas than before it was boiled, but only a good deal of sulphureous acid; the liquor, when filtered and placed in a cool place, gave in about twelve hours a considerable quantity of white needle-like crystals, which, in all the experiments, discovered the properties of sulphuret of barytes; the liquor when decanted, announced the same character. These experiments prove, that the residue No. 3 was, in its principles, very different from the residues Nos. 1 and 2.

The phenomena which these experiments presented enable me to explain, with some degree of certainty, the manner in which they are produced. When the oxyd of manganese was thrown into the solution of sulphuret of barytes, the oxygen of this last acted principally upon the sulphuretted hydrogene of the first *; it produced water and sulphureous acid, which, united to a part of the barytes, became transformed into sulphite of barytes; whilst the oxyd of manganese, then less oxydated, took also the sulphur from the barytes, without making any considerable change in it, and without forming a true metallic sulphuret. For this reason, when an acid was poured upon the residue, it could not disengage sulphuretted hydrogene gas.

When this residue was afterwards heated, it sublimed,

* This translation is correct; but we apprehend there must be some error in the original.

at a moderate heat, one part of the sulphur which was but slightly combined; while in a greater heat, that which remained acted still more powerfully upon the oxyd of manganese, disoxydising it still more (which is manifested by the disengagement of sulphureous acid) and then forms, by uniting with it, a metallic sulphuret; from which the sulphuretted hydrogene gas may then be disengaged by the acids. By treating with heat the solution of sulphuretted barytes with the oxyd of manganese, all the sulphur (to judge by the observations related on the manner of treating the residue No. 3), is converted into sulphureous acid, which, by the means of a subsequent heat, is transformed into sulphuric acid, by the attraction of a greater quantity of oxygene. For this reason, this last acid, having been used to wet the residue, after the change, cannot disengage sulphureous acid.

Recapitulation.

1°. The solution of sulphuretted barytes lost its sulphur by a simple agitation with oxyd of manganese.

2°. In the ordinary temperature, it then formed sulphite of barytes and oxydule of sulphuretted manganese; while in heating the mixture, it formed only sulphite of barytes, and the oxyd of manganese passed only to an inferior degree of oxydation.

3°. By heating, the residues obtained after these two processes underwent changes, which, in the first, is principally owing to a greater disoxydation of the oxyd of manganese, and to a more intimate combination with the sulphur; but which, in the other, appeared to consist, on the contrary, in the transmutation of sulphureous acid into sulphuric acid, perhaps also in the volatilization of a part.

4°. However exact the observation of M. Dizé may be, relative

relative to the separation of sulphur from sulphuret of barytes, by oxyd of manganese, and however clear may be the causes of this result, after the experiments that have been made, it appears also to be demonstrated, by the same phenomena, that this process cannot be used with advantage to obtain pure barytes, because there is always more or less sulphite of barytes formed during this operation, which infallibly diminishes the quantity of barytes, and renders the residue impure.

After being led by the experiments cited, and some others, to draw this last conclusion, I resolved to try if, by exposing to the air the solution of barytes above-mentioned, the major part of the barytes, which ought to be considered as not sulphuretted, could be combined with carbonic acid, and separated from the barytes really sulphuretted; for three parts of heavy spar contain but one part of sulphuric acid, in which there is to be found only about two-fifths of sulphur; from which it follows that sixteen ounces of heavy spar, holding eleven ounces, two drams, and two scruples of pure barytes, can only contain two ounces, two drams, and eight grains of sulphur. Nevertheless, as the heat which must be used to convert the heavy spar into sulphuret of barytes, causes the sulphur to evaporate, it may be supposed what quantity of sulphur goes to two ounces. According to this supposition, the sulphur does not amount even to a sixth part in the barytes obtained by the process described; consequently, it ought to give a very considerable overplus of pure barytes, since it is proved that a part of the sulphur, to become soluble in water, requires at most two parts of barytes.

For this reason, a solution of an ounce and a half of sulphuretted barytes was exposed in an earthen vessel, in a situation where much carbonic acid was disengaged; and

and the skim which formed on the surface was stirred in from time to time.

After four weeks, no perceptible skim was formed for the space of several days. The solution still appeared the same as before, as far as could be judged from its taste, smell and appearance. The separated part, being washed and dried, amounted to an ounce and a half. In order to see if, besides the carbonate of barytes, it would also form sulphate of barytes, or whether it would disengage sulphur, this precipitate was put into six ounces of distilled water, and some pure muriatic acid was mixed with it, a little at a time; it then developed, besides the carbonic acid, a great quantity of sulphureous acid, which gave in the residue a considerable portion of powder very much crystallized, which might weigh about two drams. This powder was heated, after being mixed with an ounce of distilled water and half an ounce of pure muriatic acid; the quantity of sulphureous acid vapours that were disengaged proved that the residue was sulphite of barytes, which was almost entirely dissolved.

It is to be concluded from the foregoing experiments, that it is not possible to obtain in this way pure carbonate of barytes; at the same time this observation confirms what M. Berthollet has said, that in the decomposition of alkaline sulphuretts dissolved by the air, it forms sulphureous acid, but no sulphuric acid; this last only forms it, when a great quantity of oxygene presents itself all at once to the sulphur, as by nitric acid, muriatic oxygenated acid, and in the detonation of salt-petre.

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Abstract

Abstract of a Memoir on the Theory of Capillary Tubes.

By M. Laplace.

From the Journal de Physique.

THIS memoir, which is intended to appear among those of the first class of the Institute, is preceded by the following analysis of the theory contained in it, which has been communicated to us by the author.

Clairaut was the first who subjected to an accurate and rigorous analysis the phenomena of capillary tubes, in his "Treatise on the Figure of the Earth." But his theory, which is explained with that elegance which characterises this ingenious and important work, does not, however, give us the explanation of the principle of these phenomena, which consists in the elevation of the fluid above its level, in tubes of the same matter, being in the inverse ratio of their diameters. This great geometrician contents himself with observing, though without proving it, that there must be an infinity of laws of attraction which, substituted in his formulus, give this result. I have long endeavoured to supply what was wanting in the theory of Clairaut: new researches have at length enabled me not only to ascertain the existence of such laws, but also to shew that all the laws in which the attraction ceases to be sensible at a sensible distance, give the elevation of the fluid in the inverse ratio of the diameter of the tube, and hence results a complete theory of this kind of phenomenon.

Clairaut supposes that the action of the capillary tube is sensible upon the infinitely narrow column of fluid which passes through the axis of the tube. In this I differ from him in opinion, and think with Hawkesbie, and many

many other philosophers, that the capillary action, like the refractive power and all the chemical affinities, is sensible only at imperceptible distances. Hawkesbie has observed, that in glass tubes, whether very thin or very thick, water always rose to the same height, as long as the internal diameters were the same. The cylindrical layers of the glass, which are at a sensible distance from the interior surface, do not therefore contribute to the ascent of the water, though in each of them, taken separately, this fluid would rise above its level. Moreover, a very simple experiment proves the truth of this principle. If we cover with an extremely-thin layer of oily matter the internal surface of a tube of glass, we cause the capillary effect sensibly to disappear. Nevertheless, the tube always acts in the same manner upon the fluid column at its axis; for the capillary attractions must be transmitted through bodies, as we observe with regard to gravity, and the magnetic, and even electric, attractions and repulsions. Newton, Clairaut, and all the geometricians who have subjected this kind of attractions to calculation, have set out from this hypothesis. The capillary effect being therefore destroyed by the interposition of a layer of greasy matter, however then it may be, the action of the tube must be insensible at a sensible distance.

The following phenomenon furnishes a new proof of the principle which I have just laid down. It is known, that by a strong ebullition of mercury in a capillary tube of glass, this fluid is raised to the level, and even above it, if the boiling is continued for a greater length of time. This phenomenon appears to me to depend upon the slight layer of water which, in the ordinary state, lining the interior surface of the tube, weakens the reciprocal action of the glass and the mercury; an action which in-

creases more and more in proportion as by the ebullition of this fluid in the tube the thickness of this layer is diminished. In the experiments which I have made with M. Lavoisier upon barometers, by boiling mercury in them, we caused the convexity of its interior surface to disappear; we even rendered it concave; but we were always able again to re-establish the effect of the capillarity by introducing a drop of water into the tube. If we now consider how thin the layer of water must be, especially when the tube and the mercury have been well dried, which is not sufficient to destroy the capillarity, we shall see that the action of the glass upon this fluid is sensible only at insensible distances.

Setting out from this principle, I determine, by the formulas of my *Traité de Mécanique Celeste*, the action of a fluid mass terminated by a concave or convex spherical surface, upon an interior fluid column inclosed in an infinitely-narrow channel, which passes through the axis of this surface. By this action I mean the pressure which the fluid contained in the channel would exert, by virtue of the attraction of the whole mass, upon a plane base, situated in the interior of the channel, perpendicularly with its sides, at any sensible distance from the surface, this base being taken for unity. I shew that this action is less or greater than if the surface were plane; less, if the surface is concave; greater, if the surface is convex. Its analytical expression is composed of two terms; the first, which is much greater than the second, expresses the action of the mass terminated by a plane surface, and I think that upon this term depend the phenomena of the adhesion of bodies to each other, and of the suspension of mercury in a barometer-tube, at a height two or three times greater than what is due to the pressure of the atmosphere. The second term expresses the part of the

action

action due to the sphericity of the surface: it is positive or negative, according as the surface is convex or concave. I shew that in both cases this term is in the inverse ratio of the radius of the spherical surface. Hence I reduce this general theorem; *viz.* that in all the cases where the attraction is sensible only at insensible distances, the action of a body terminated by a curved surface upon an interior channel, infinitely narrow and perpendicular to this surface at any point, is equal to half the sum of the actions upon the same channel of two spheres, having for radii the largest and the smallest of the osculating radii of this surface at this point. By means of this theorem, and of the laws of the equilibrium of fluids, we may determine the figure which must be assumed by a fluid mass acted upon by gravity. I prove that in a cylindrical tube, of a considerable diameter, the section of the surface of the fluid by a vertical plane is a curve of that kind which geometricians term *elastic*, and which are formed by an elastic plate, bent by weights; this is because in this section, like in the elastic curve, the force due to the curve is reciprocal to the osculating radius. If the tube be very narrow, the surface of the fluid approaches the nearer to that of a spherical segment, as the diameter of the tube is smaller. I then prove that, in different tubes of the same matter, these segments are very nearly similar; whence it follows, that the radii of their surfaces are very nearly proportional to the diameters of the tubes. This similarity of the spherical segments will be evident, if we consider that the distance at which the action of the tube ceases to be sensible, is imperceptible; so that if, by means of a very powerful microscope, we should make it appear equal to a millimeter, it is probable that the same magnifying power would give to the diameter of the tube an appa-

rent magnitude of several metres. The surface of the tube may therefore be considered as being very nearly plane in a radius equal to this distance; the fluid in this interval will therefore descend or ascend from this surface very nearly as if it were plane: beyond, the fluid being sensibly subject only to the action of gravity and to its action upon itself, its surface will be very nearly that of a spherical segment, the extreme sides of which, being those of the surface at the limits of the sphere of sensible activity of the tube, will be almost equally inclined to the horizon in the different tubes; whence it follows, that all these segments will be very nearly similar.

The comparison of these results gives the true cause of the ascent or descent of fluids in capillary tubes, in the inverse ratio of their diameters. If by the axis of a tube of glass, we conceive an infinitely-narrow channel, which being curved a little below the tube, terminates in the plane and horizontal surface of the water of a vessel into which the lower extremity of the tube is immersed; the action of the water of the tube upon this channel will be less, in proportion to the concavity of its surface, than the action of the water of the vessel upon the same channel; the fluid must therefore ascend in the tube to make up for this difference; and as it is, by what precedes, in the inverse ratio of the diameter of the tube, the elevation of the fluid above its level must follow the same proportion.

If the fluid is mercury, its surface in the interior of a capillary tube of glass is convex; its action upon the channel is therefore more powerful than that of the mercury of the vessel, and the fluid must descend in the tube in proportion to this difference, and consequently in the inverse ratio of the diameter of the tube.

Thus

Thus the attraction of the capillary tubes has no influence on the ascent or descent of the fluids which they contain, except in determining the inclination of the first planes of the surface of the interior fluid, which are extremely close to the sides of the tube, an inclination upon which depends the concavity or the convexity of this surface, and the size of its radius. If, by the effect of the friction of the fluid against the sides of the tube, we augment or diminish the curvature, the capillary effect will be augmented or diminished in the same proportion.

It will be interesting to ascertain the radius of the curvature of the surface of the water inclosed in the capillary tubes of glass. This may be done by means of a curious experiment, which renders sensible the effects both of the concavity and of the convexity of the surfaces. It consists in plunging into water, to a known depth, a capillary tube of glass, the diameter of which is also known. The lower extremity of the tube being closed with the finger, it is taken out of the water, and its exterior surface slightly wiped. When the finger is removed, the water is seen to sink in the tube, and form a drop of water at its lower basis; but the height of the column is always greater than the elevation of the water in the tube above the level. This excess is owing to the action of the drop upon this column on account of its convexity; and it is observed to be more considerable in proportion as the diameter of the drop is smaller. The length of the fluid column employed to form this drop determines its mass; and as its surface is spherical, as well as that of the interior fluid, if we know the height of the fluid above the summit of the drop, and the distance of this summit from the plane of the inferior basis of the tube, it will be easy thence to deduce the radii of these

two

two surfaces. Some experiments lead me to be believe that the surface of the interior fluid approaches nearly to that of a hemisphere.

Clairaut has made this singular remark: That if the law of the attraction of the matter of the tube for the fluid differs only by its intensity from the law of the attraction which the fluid exerts upon itself, the fluid will rise above the level as long as the intensity of the first of these attractions shall exceed the half of the intensity of the second. If it is exactly the half of it, it is easy to ascertain that the surface of the fluid in the tube will be horizontal, and that it will not raise itself above the level. If these two intensities are equal, the surface of the fluid in the tube will be concave and that of a hemisphere; and an elevation of the fluid will take place. If the intensity of the attraction of the tube is none, or insensible, the surface of the fluid in the tube will be convex, and that of a hemisphere; and a depression of the fluid will take place. Between these two limits, the surface of the fluid will be that of a spherical segment; and it will be concave or convex, according as the intensity of the attraction of the matter of the tube for the fluid will be greater or less than the half of that of the attraction of the fluid for itself.

If the intensity of the attraction of the tube for the fluid surpasses that of the attraction of the fluid for itself, it appears probable to me that then the fluid, attaching itself to the tube, will form an interior tube, which alone will elevate the fluid, the surface of which will be concave, and that of a hemisphere. I presume that this case is that of the water in a tube of glass.

After having considered the fluids terminated by spherical surfaces, I consider them terminated by cylindrical surfaces.

surfaces. This case is that of a fluid inclosed between two parallel planes very near to each other, and having their lower extremities immersed in a vessel filled with the same fluid. I find by analysis, that the fluid must rise or fall according as the cylindrical surface of the fluid is concave or convex, and that this elevation or this depression also follows the inverse ratio of the mutual distance of the planes. I find, moreover, that the elevation or the depression is equal to that which would take place in a cylindrical tube, of which this distance were the semi-diameter. Having arrived at this result of analysis, I proposed to M. Hauy to verify it by experiments; and he has found it entirely conformable to those which he made at my solicitation. Since then, reading what has been written upon the capillary action, I found that these experiments had already been made with great attention before the Royal Society of London, and under the eye of Newton, and that their result is exactly conformable to that of the analysis. This may be seen from the following passage in his Optics; an admirable work, in which that profound genius has gone beyond his age in a great number of original views which modern chemistry has confirmed. "The following (he says, Quest. 31.) "are some experiments of the same kind. If two plates "of plane polished glass (suppose two pieces of a weil-"polished looking glass) are joined together at a very "small distance from each other, their sides being pa-"rallel, and their lower extremities immersed to a small "depth in a vessel full of water; this water will ascend "between the two pieces of glass, and in proportion as "they are nearer to each other, the water will ascend "to a greater height. If their distance is about a hun-"dredth part of an inch, the water will rise to the "height

" height of about an inch, and if the distance is greater " or smaller, in whatever proportion it may be, the " height will be nearly in the reciprocal proportion " of the distance. If we immerse in standing water the " end of a very fine tube of glass, the water will rise in " the tube to a height which will be reciprocally propor- " tional to the diameter of the cavity of the tube, and " will be equal to the height to which it rises between " the two plates of glass, if the semi-diameter of the ca- " vity of the tube is equal to the distance between the " plates, or nearly so. Moreover, all these experi- " ments succeed as well *in vacuo* as in the open air, " as has been proved in presence of the Royal So- " ciety; and consequently they do not depend in any " degree upon the weight or the pressure of the at- " mosphere."

The capillary phenomena of inclined planes, and of conical and prismatic tubes, are so many corollaries to my analysis. Thus we observe, that a small column of water, in a conical tube, open at both extremities, and kept in a horizontal position, rises towards the summit of the tube, and we see, from what has preceded, that this must be so. In fact, the surface of the fluid column is concave at its two extremities; but the radius of its surface is smaller at the summit than at the base; the action of the fluid upon itself is therefore less towards the summit, and consequently the fluid must tend towards this end. But if the fluid column is mercury, its surface is then convex, and its radius is still less towards the summit than towards the base; but by reason of its convexity, the action of the fluid upon itself is greater towards the summit, and the column must tend towards the base of the tube.

This

This action may be counterbalanced by the weight of the column itself, and it may be kept suspended in equilibrio, by inclining the axis of the tube to the horizon. A very simple calculation shews that if the length of the column is very small, the sinus of the inclination of the axis is then very nearly in the inverse ratio of the square of the distance of the middle of the column from the summit of the cone; which equally takes place if, instead of causing a drop of fluid to move in a conical tube, we cause it to move between two planes, forming a very small angle with each other. These results are entirely conformable to experience, as may be seen in Newton's Optics (Quest. 31).

Calculation shews us, moreover, that the sinus of the inclination of the axis of the cone to the horizon is very nearly equal to a fraction of which the denominator is the distance from the middle of the drop to the summit of the cone, and the numerator the height to which the fluid would rise in a cylindrical tube, of which the diameter were that of the cone at the middle of the column. If two planes which inclose a drop of the same fluid form together an angle equal to double the angle formed by the axis of the cone and its sides, the inclination to the horizon of the line which equally divides the angle formed by the planes, must be only half of that of the axis of the cone, in order that the drop may remain in equilibrio.

The preceding theory gives also the explanation and the measure of a singular phenomenon which experience presents to us. Whether the fluid rises or falls between two vertical and parallel planes which have their lower extremities immersed in this fluid, these planes tend to approach each other. Analysis shews us that, if the fluid

rises between them, each plane experiences, from without to within, a pressure equal to that of a column of the same fluid, of which the height were the half of the sum of the elevations above the level, of the points of contact of the interior and exterior surfaces of the fluid with the plane, and of which the base were the part of the plane comprised between the two horizontal lines drawn through these points. If the fluid sinks between the planes, each of them will likewise experience, from without to within, a pressure equal to that of a column of the same fluid, of which the height were half the sum of the oppressions below the level of the points of contact of the interior and exterior surfaces of the fluid with the plane, and of which the base were the part of the plane comprised between the two horizontal lines drawn through these points.

In general, if we compare the theory which I propose with the numerous experiments of philosophers upon the capillary action, we shall see that the results obtained in these experiments are deducible from it, not by vague and always uncertain considerations, but by a series of geometrical reasoning, which appears to leave no doubt respecting the truth of this theory. I wish that the application of analysis to one of the most curious objects of natural philosophy may interest geometricians, and induce them more and more to multiply these applications, which combine with the advantage of giving stability to physical theories, that of improving analysis itself, by frequently requiring new artifices of calculation.

Experiments

Experiments and Observations on the mutual Adhesion of the Molecules of Water. By Count RUMFORD.

Read at the Public Sitting of the NATIONAL INSTITUTE, July 6, 1806.

WE often see that small solid bodies, of a specific gravity much superior to that of water, float upon the surface of that liquid; such, for example, as small grains of sand, very fine filings of metals, and even very small needles.

A phenomenon so extraordinary could not fail to attract the attention of philosophers. It lately was mentioned at a sitting of the first class of the Institute; and as this remarkable fact is intimately connected with a subject of research in which I have been for a long time engaged, I shall give to this Assembly an account of some experiments which I have made with a view to elucidate this subject, and which have afforded me some very interesting results.

Suspecting that the presence of the air attached to the surfaces of the small ponderous bodies which float upon water (which is generally looked upon as the immediate cause of their suspension) was not indispensably necessary to the success of this experiment, I made the following investigations.

Experiment I. Having half filled with water a small wine-glass, an inch and a half in diameter at the top, I poured upon the water a layer of vitriolic ether, a quarter of an inch in thickness; and when the whole was perfectly tranquil, I took up with a pair of tweezers a very small needle, which I introduced into the ether, holding it in a horizontal position, and bringing it gently to the

distance of about a line above the surface of the water, I let it drop.

The needle descended to the surface of the water, where it remained floating.

Experiment II. Having melted some tin, I poured it into a spherical wooden box, and strongly shaking the box, the metal, as it cooled, was reduced into a powder, which was afterwards passed through a sieve. On examining this powder with a magnifying glass, it appeared to be composed of small globules of different sizes; but these globules were too small to be distinguished without the aid of the glass.

I took a very small quantity of this metallic powder upon the point of a spatula, and poured it gently, from the height of a quarter of an inch, upon the surface of the ether which rested upon the water contained in the glass.

The whole of this powder sunk through the layer of ether, and having reached the surface of the water, it there remained floating.

Experiment III. Having poured a large drop of mercury upon a porcelain plate, I crushed it, and formed of it a great number of small globules.

In order to take up and remove one by one these small globules, I had a small instrument made in the form of a hoe. It was a wire, five inches long and half a line in diameter, bent at one of its extremities into a right angle. The bent part, which was two lines in length, was flattened with a hammer, and afterwards sharpened, and made a little concave.

By means of this instrument I took up a small globule of mercury, about a fifth of a line in diameter, and carefully removing it, I conveyed it to the distance of about half a line from the surface of the water upon which the ether

ether rested, then inclining the edge of the small instrument a little forward, I let the globule of mercury fall gently upon the surface of the water.

The globule having descended to the surface of the water, it there remained floating.

When holding my eye lower than the surface of the water, I viewed the globule from below upwards, through the glass; it appeared as if suspended in a kind of sack, a little below the level of the surface of the water.

Having placed a second globule of mercury upon the surface of the water, it immediately moved towards the first, and approaching it with an accelerated motion, it precipitated itself into the same sack, which then became longer; but the two globules did not intermingle with each other.

Having placed a third globule upon the surface of the water, it joined itself to the two others; but the weight of these three globules united, being too great to be supported by the kind of pellicle which had formed at the surface of the water, the sack was broken, and the globules descended through the water to the bottom of the glass.

When the experiment was made with a somewhat larger globule of mercury, for example, with one of a fourth or a third of a line in diameter, it always broke the pellicle of the water, and descended through this liquid to the bottom of the glass; but when the viscosity of the water was increased, by dissolving a little gum-arabic in it, still larger globules of mercury were supported upon the surface of the liquid.

A globule of mercury, of a size adapted to be supported by the water upon its surface, if placed gently upon it, nevertheless always forced itself a passage through the pellicle of the water, when made to fall upon it from a somewhat greater height.

All

All the preceding experiments were repeated with a layer of essential oil of turpentine, and afterwards with a layer of olive-oil, placed upon the water contained in the glass, instead of the layer of ether; and the results were similar in every respect. I thought, however, that I perceived the globules of mercury which remained suspended upon the water, to be a little larger when the surface of the water was covered with a layer of oil, than when it was covered with a layer of ether; and in the experiments which were made with the powder of tin poured upon the oil, the finest parts of this powder, in very small quantity, floated upon the surface of the oil.

Experiment IV. Having found means of placing a layer of alcohol upon the water contained in the glass, in such a manner that the two liquids appeared to be as completely distinct from each other as when a layer of oil is placed upon the water; I poured from a very small height, a small quantity of very fine powder of tin upon the alcohol.

The whole of this powder descended through the layer of alcohol, and afterwards through the water, without having given the slightest indication of having found any resistance on arriving at the surface of the water.

Although this surface appeared very distinct to the sight, nevertheless, judging from the manner in which the metallic powder descended to the bottom of the glass, I could not help believing that it no longer existed; and indeed it probably was destroyed by the chemical action of the alcohol placed in contact with it.

In order better to examine this kind of pellicle which forms at the surface of the water, I made the following experiment.

Experiment V. Into a cylindrical glass, with a solid foot, 14 lines in diameter and ten inches in height, I poured very limpid

limpid water to the height of 9½ inches, and placed upon the water a layer of ether three lines in thickness. I placed then upon the surface of the water several small solid bodies, which there remained suspended; such as a small globule of mercury, some pieces of extremely fine silver wire from two to three lines in length, and a small quantity of powder of tin. When the whole was perfectly tranquil, I took the glass in my two hands, and raising it with caution, I turned it two or three times round its axis, holding it in a vertical position. All the small bodies suspended upon the surface of the water turned with the glass, and afterwards stopped with it; but the liquid water situated below the surface, did not begin at first to turn with the glass which contained it, nor did its rotary motion cease immediately when I had ceased to turn the glass round its axis: in short, all the appearances indicated the existence of a real pellicle upon the surface of the water, and that this pellicle was strongly attached to the sides of the glass so as to be compelled to move along with it.

On examining with a good magnifying glass the small bodies supported upon the surface of the water, it was impossible to doubt the existence of the pellicle in question, especially when it was touched with the point of a needle; for when this was done the small bodies resting upon this pellicle were seen thrown all at the same time into a tremulous motion.

Having let this small apparatus stand in a quiet chamber till the layer of ether which rested upon the water was entirely evaporated, I examined it anew with the magnifying glass. I found the surface of the water in precisely the same state as before; the small solid bodies were still upon it, and had retained the same places and the same distances from each other.

When

When this experiment was made with a cylindrical glass of a much larger diameter, the effects of the adhesion of the pellicle of the water to the sides of the vessel upon the parts of this pellicle situated near to the axis of the vessel were less sensible; it was difficult to prevent the small weighty bodies supported upon the surface of the water from uniting; when united, they frequently formed masses too heavy to continue to be supported; and having broken the pellicle of the water, they fell to the bottom of the vessel.

If the molecules of water adhere strongly to each other, a necessary consequence of this adhesion must be, I should think, the formation of a kind of pellicle upon the surface of this liquid, and even *upon all its surfaces*, whatever otherwise may be the mobility of these molecules, or rather of the small liquid masses composed of a great number of these molecules, when they are at a distance from the surface, and enjoy a free fluidity.

When a small solid body placed upon the surface of the water becomes wet, it is immediately *below the pellicle of this liquid*, and this pellicle can no longer prevent its descent; and now the viscosity of the liquid begins to manifest itself in a quite different manner; but in a manner infinitely less sensible than when it acts upon the confines of the liquid: it is, however, not yet time to discuss this part of our subject.

With a view to render evident to the senses the resistance which the pellicle of the lower surface of a layer of water opposes to a solid body traversing this layer, and falling freely from the top to the bottom, I made the following experiment.

Experiment VI. Having filled a small glass with a foot about half full of very pure and clean mercury, I poured upon this mercury a layer of water three lines in thickness,

ness, and upon the water a layer of ether two lines thick.

When the whole was tranquil, I took, with the small instrument above described, a globule of mercury, about a third of a line in diameter, and let it fall through the layer of ether.

This globule, being too heavy to be supported by the pellicle upon the upper surface of the layer of water, broke it, and descended through this liquid; but when it had arrived at the lower surface it was stopped, and remained there, retaining its spherical form.

I moved this globule with the end of a feather; I even compressed it; but it still retained its form, without mixing with the mass of mercury, upon which it seemed to rest.

It was undoubtedly the pellicle of the inferior surface of the layer of water which prevented this contact; and as this pellicle was supported by the mercury upon which it rested, I was not at all surprised to find that it could bear, without breaking, a much larger globule of mercury than the pellicle of the upper surface of the water had been able to support.

In order to convince myself that the viscosity of the water was the cause of the suspension of the globule of mercury at the bottom of the water, I repeated this experiment, and varied it by substituting water that contained a certain quantity of gum-arabic in solution, in place of the pure water, and I actually found that globules much larger still were supported when the viscosity of the water was augmented by this means.

In order to demonstrate this fact in another manner, I again varied the experiment, by placing immediately upon the mercury a simple layer of ether. The molecules of this liquid appear to have very little adhesion to

each other; for which reason I imagined that the kind of pellicle that must form at its surface could have but very little strength. The results of the experiment fully confirmed this conjecture.

The smallest globules of mercury which I caused to fall through this liquid, rarely failed to mix immediately with the mass of mercury when they arrived at its surface, and entirely to disappear; nor could I ever bring to float upon ether, either a globule of mercury, or the smallest atom of metallic powder, or any other body specifically heavier than this liquid.

The results of the experiment were sensibly the same when I substituted alcohol in place of ether.

It is well known that ether evaporates with great rapidity. Is not this another proof that the molecules of this liquid adhere to each other with much less force than those of water? But the following experiment confirms this fact in a decisive manner.

Experiment VII. Having half filled with mercury a small cylindrical glass, I placed upon the mercury a layer of ether, four lines in thickness, and blew upon the ether with a common bellows.

In less than a minute the whole of the ether had disappeared.

Having made a similar experiment with water instead of ether, its volume was not sensibly diminished in the space of a minute.

Objects which we have continually before our eyes from our infancy are rarely subjects of our meditation, scarcely even of our attention.

We see without surprise immense clouds of dust raised by the wind, and carried to great distances; and yet we know that each particle of this dust is a real rock, almost three times specifically heavier than water, and so large

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in size that its form can be perfectly distinguished by means of a good microscope.

We also see without surprise, that water, which is much lighter than dust, and composed of molecules incomparably smaller, is nevertheless not carried away by the wind in the same manner.

In order to convince ourselves that the molecules of water are strongly attached to each other by adhesion, and that they must be so in order to prevent the greatest disorder in the world, we need only figure to ourselves the consequences which would inevitably result from the destruction of this force of adhesion.

The molecules of water would be raised and carried away by the wind with infinitely greater facility than the finest and lightest dust: every strong and continued wind blowing off the sea would bring along with it a great inundation; navigation would be impossible, and the borders of every sea, lake, or large river would be uninhabitable.

The adhesion of the molecules of water with each other is the cause of the preservation of this liquid in masses. It covers its surface with a very strong pellicle, which defends and prevents it from being dispersed by the winds. Without this adhesion, water would be more volatile than ether, more fugitive than dust.

But this adhesion is the cause also of other phenomena, of the highest importance in the economy of nature.

The viscosity which results from the mutual adhesion of the particles of water, renders this liquid capable of holding in solution all kinds of bodies, even the lightest and the heaviest bodies, provided always that they be reduced to very minute particles.

I have found by a calculation, founded upon facts, which have appeared to me decisive, that a solid globule

of pure gold, of a diameter of a three hundred-thousandth part of an inch, would be suspended in water by the effect of its viscosity, even though this small body were completely wetted and submersed in a tranquil mass of this liquid.

This viscosity, or want of perfect fluidity in water, which causes it to hold suspended all sorts of substances in solution, renders it eminently adapted to be *the vehicle of the nourishment of plants and animals*; and we accordingly see that it is water which exclusively performs this office.

If the mutual adhesion of the molecules of water should cease, if the fluidity of this liquid should become perfect, all living beings would perish of inanimation.

When I thus contemplate the simplicity of the means which Nature employs in her operations, how can I refrain from expressing my admiration and adoration for the great Author of all these wonders!

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Artificial Turf.

THE village of Sofnofska, in the Southern part of the Russian dominions, on the banks of the Wolga, contains about eighty families. This colony, like many others in the same countries, is totally destitute of wood. A substitute for it was invented in the year 1788, by Frederic Risch, one of the original settlers in the Isle of Rugen; which consists in the fabrication of an *artificial turf* from dung and straw. In order to procure a large supply

supply of the first of these two ingredients, a great quantity of litter is given to the cattle. In proportion as it is converted into dung it is gradually collected into heaps, and left to putrefy and heat during the winter. After the first rural labours have been completed in the spring, this dung is conveyed to a dry place near the water. It is heaped up to the height of some feet, and a small quantity of straw being added to it, it is moistened with water. It is then trodden down by horses and oxen. As soon as it begins to dry it is cut, after the manner of turf, and stacked. When perfectly dry, it is carried under cover for winter-fuels. The Tartars of the Crimea have been for a long time in the habit of using this dung-turf. It burns almost like pit-coal, with a flame, and emits a very remarkable heat. Five or six pieces are sufficient to heat a stove. With a few pair of horses, or yokes of oxen, the whole quantity which a family requires for winter consumption may in a short time be procured. This method may become of utility in some parts of France, where wood is extremely rare, and where no other fuel is commonly used than cow-dung, dried by the sun in the summer, and carefully collected.

Meteor.

A very singular and brilliant Meteor was seen by many of the inhabitants of London, in broad day-light, on Thursday afternoon, the 17th of July, just about eight o'clock, passing in the southern and western parts of the hemisphere from about S.E. to N.W.: it seemed about one-fourth of the apparent diameter of the Moon, but more brilliant than Venus ever appears; and moved with very great swiftness, nearly in a horizontal direction, leaving a conical tail of light and sparks behind it.

List of Patents for Inventions, &c.

(Continued from Page 160.)

JUNE.

RALPH DODD, of Change alley, in the city of London, Engineer; for a method of applying steam for the forcing and raising of water, heavy bodies, and working machinery, in a more simplified manner than has hitherto been practised. Dated June 6, 1806.

EDWARD MASSEY, the younger, of Newcastle, in the county of Stafford, Nautical Instrument-maker; for improvements in the construction of an instrument or apparatus for taking soundings at sea, whereby the same will be much more simplified; for which instrument or apparatus he has already obtained letters patent, bearing date the 24th day of March, 1802 *. Dated June 6, 1806.

WILLIAM DEVERELL, of Charles-street, Blackfriars Road, in the county of Surrey, Engineer; for improvements in the mode of giving motion to hammers, stampers, knives, sheers, and other things, without the application of wheel, pinion, or any rotative motion; by means of various powers now in common use, whereby much labour and expense will be saved. Dated June 6, 1806.

LAWRENCE GWYNNE, of Christ's Hospital, in the city of London, Gentleman, and PETER NOBLE, of the London Road, in the county of Surrey, Engine maker; for improvements in chain and common pumps; whereby the latter will act as a fire-engine for sea and land purposes. Dated June 6, 1806.

EDWARD HEARD, of London, Chemist; for certain means of obtaining inflammable gas from pit coal in such a state that it may be burned without producing any offensive smell. Dated June 12, 1806.

* Specification inserted in the third volume of the present series.

SAMUEL

SAMUEL PHELPS, of Cuper's Bridge, Lambeth, in the county of Surrey, Esquire; for a method of making kelp, barilla, or other vegetable or mineral alkali, by fermentation, and other means, in addition to combustion. Dated June 17, 1806.

WILLIAM LESTER, of Piccadilly, Engineer; for an improved rotary motion or engine to communicate power to machines. Dated June 19, 1806.

WILLIAM CLARK, of Cerne Abbas, in the county of Dorset, Clock-maker, and JOSEPH BUGBY, of Yeovil, in the county of Somerset, Schoolmaster; for improvements in a machine for spinning hemp, flax, tow, and wool. Dated June 19, 1806.

THOMAS BOURNE and WILLIAM CHAMBERS, Scale-Beam-makers, and CHESTER GOULD, Mechanick, all of Birmingham, in the county of Warwick; for a machine or engine for roasting meat by the power of steam, and for other purposes where small powers are necessary. Dated June 24, 1806.

JULY.

JOHN DAVENPORT, of Langport, in the county of Stafford, Glass-maker; for a method of ornamenting glass in imitation of engraving or etching, by which means borders, cyphers, courts of arms, drawings, and the most elaborate designs may be executed in a stile of elegance hitherto unknown. Dated July 4, 1806.

JOHN CURR, of Sheffield, in the county of York; for a method of applying the cables of ships and vessels upon the windlasses, capstans, or drums thereof, whereby the necessity of conveying away the loose ends of the said cables is prevented; by which methods the cables are more commodiously applied to their work, and more certain of bringing ships and vessels safe to anchor. Dated July 4, 1806.

BRYAN

BRYAN DONKIN, of Fort Place, Bermondsey, in the county of Surrey, Engineer, and HENRY MAUDSLAY, of Margaret-street, Cavendish-square, in the county of Middlesex, Engineer; for a method of combining wheel-work together, so as to produce any required proportion of velocity between the weight and the first mover. Dated July 24, 1806.

CHARLES DE BERENGER, of Hart-street, Bloomsbury, in the county of Middlesex, Artist; for a certain animal substance, and method of preparing and manufacturing the same, whereby the said substance becomes applicable as a substitute for horse and other hair now used for the stuffing of cushions, mattresses, carriages, sofas, chairs, &c. and all other purposes for which flocks, wool, or hair, are now generally applied; communicated to him by a certain foreigner residing abroad. Dated July 24, 1806.

HENRY FOURDRINIER, of Sherborne-lane, in the city of London, Stationer and Paper-maker; for a method of making a machine for cutting paper on a different principle from any hitherto used; communicated to him by a certain foreigner residing abroad. Dated July 24, 1806.

HENRY FOURDRINIER, of Sherborne-lane, in the city of London, Stationer and Paper-maker; for a method of making a machine for manufacturing paper of an indefinite length, laid and wove with separated moulds; communicated to him by a certain foreigner residing abroad. Dated July 24, 1806.

JOHN LAMB, of the state of New York, in North America, at present residing in King-street, in the city of London, Merchant; for improvements in and upon a machine or machinery for extracting fresh water from the salt water of the ocean, (by distillation,) and other purposes, at sea or elsewhere; communicated to him by a certain foreigner residing abroad.
Dated July 25, 1806.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LII. SECOND SERIES. Sept. 1806.

Specification of the Patent granted to RICHARD WILLCOX, *of Lambeth, in the County of Surrey, Engineer; for Machinery for the more expeditiously cutting, stripping, or plucking the various Furs, Beavers, Seals, Wool, Hair, &c. from the various Skins now cut, plucked, or stripped by Hand, and for sundry Methods of preparing and cleansing the said Skins.*

Dated December 19, 1805.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Richard Willcox do hereby declare, that my said invention is described in manner following; that is to say: First, instead of the left-hand now usually employed for holding down the fur whilst cutting, I substitute a thin plate of metal, ivory, or any other hard elastic wood, or other suitable material, capable of holding down the fur, which I place on its edge, and press close in contact with the felt of the skin, which is previ-

ously laid smooth either on a horizontal bed or on a roller (the latter however is preferable). The apparatus necessary for advancing the skin as the fur is cut is clearly exhibited in Figs. 1 and 2, in the drawing hereunto annexed (see Plate X.); namely, Fig. 1 requires the application of the hands and foot of the workman; the latter, Fig. 2, requires no other action than that of the first mover, which may be a steam-engine, or any other source of power, together with the attention of the workmen to supply the pelts or skins, as the same are necessary. Secondly, to produce a similar effect, I use or employ a metal, ivory, or ebony roller (the former however has a decided preference): the most suitable size in diameter I find to be from three quarters of an inch to one inch and a quarter, turned true, and draw-filed longitudinally with a smooth bastard file. This roller is to be moderately pressed in contact with the surface of the pelt, the said roller being turned in a contrary direction to that of the skin, whereby the fur is effectually drawn or removed out of the way of the knife, and prevented from being mutilated or cut short. For a view of the machine, with its concomitant appendages for cutting with rollers wrought by muscular power, see Fig. 3, in the said drawing annexed hereunto, with the references thereunder written. Thirdly, for effectually separating the fur, and for cutting, or cutting and plucking, in the same machine, I employ with the roller, (which in this case will admit of being a quarter of an inch less than the roller before mentioned, or about half an inch diameter, which should be smooth, and made of the strongest metal, and supported either by a larger roller working above it, or a piece of metal with a concave edge working in contact with the said first-mentioned roller, and preventing its giving way or bending from the necessary pressure it must sustain whilst

whilst round the small roller, is drawn by a connection of leading rollers attached to a drum roller;) a piece of canvass, Russia duck ticking, or other similar strong material, joined at the two extremities, and forming a perpetual web round the said rollers. By this means the canvass or other cloth being pressed in contact with the surface of the skin, and moving with about double the speed of the skin in a contrary direction, causes the fur to adhere to the said canvass in the exact order, situation, or arrangement (when cut) as it was on the skin or pelt, where it may be divided or locked, at the option of the person attending the machine. It is proper to state, that though I have here specified a small roller, supported, as affording the best means of avoiding friction, and the rollers lying in an horizontal direction, I do also, instead of the said small roller, occasionally use a bar, applied on its edge, with the corners taken off, so that the lower part forms a fixed substitute for the roller; and in the latter case the roller, &c. may be fixed either vertically or inclined, and in either case the same desirable effect will be produced. For a view of the machine complete see Fig. 5 in the said drawings annexed hereunto, and its corresponding references thereunder written. Fourthly; in the machine last described, Fig. 5, contrary to any mode heretofore practised, we cut the long or coarse hair with the fur without previously plucking, because both adhere to the canvass, &c. which being passed out of the way of the cutting part of the apparatus or machine, the same is caused to pass over one of the leading rollers where the canvass is bent nearly to a right angle, so as to introduce a metal plate as close as possible to the surface of the fur attached to the canvass, as described; the long hair now usually plucked comes in contact against the edge of the said plate, whilst a

roller, studded with different rows or locks of hair, leather, or any other flexible metal or elastic matter, which being driven in the same direction with the fur, effectually brushes, scrapes, wipes, or separates the long hair cut from the skin from the fur by pressing it against the edge of the said plate, whence it is conveyed into a trough, and prevented from falling or mixing with the fur again. It is necessary to observe in this place, that the locks of hair, leather, &c. put into the said roller or rake, may be put in what form the maker shall judge or think proper. All that is essentially necessary for him to observe is, that only a small part should come in contact at each time with the long hair, as it would otherwise take up the fur with the long hair, and, by mixing them together, spoil the fur. Fifthly, to strengthen the said skins, and prevent the possibility of delay in case the pelts being cut, I fix the skins (previously to cutting) on a strong canvass cloth, or other similar article, covered with a cement composed of wax, resin, grease, and a little ochre, or of pitch, resin, oil, and brimstone, or of paste and resin mixed, and put on the skin, and then pressed on the tick or cloth; any of these adhesive compounds will answer the same purpose. The first and second composition or cement requires to be hard enough to sustain the pressure of the canvas, and so tough as not to break when turning round the rollers, which is easily effected and suited to the difference of the temperature either in the room or in the atmosphere, by adding a little more oil or grease to the composition in cold weather, should the cement be too brittle, or *vice versâ*, adding resin or brimstone in warm weather, should the composition be too soft. However, this must be left to the management of the person working the machine, it being impossible to give any determinate proportion for making the

the said cement, as it will require to be altered as above, according to the temperature of the weather. Sixthly; as the fur on some particular skins is very short, and therefore cannot be separated by the machine here described, hence, for plucking such skins, I fix the extremity of the skin to or between rollers, so as to draw it slowly over a roller with a second very small roller in front of the skin, whilst a third larger roller, resembling a worm, or quick flat thread screw, when viewed in its longitudinal direction, moves with a greater velocity in a contrary direction to the skin, whereby a portion or part of the long hair is caught each revolution, and jammed or pressed between a part of the worm or thread, and the same roller in front of the skin is thereby plucked out of the skin. For a farther description see Fig. 4 in the said drawings hereunto annexed, with the references thereunder written. Seventhly; my knives form an important part of this my invention, being made of the best hardened tempered steel, which is fluted, grooved, or toothed on the face-side, so that when ground for use on the opposite surface it obtains an edge similar to a very fine saw, and being principally made circular, (particularly when annexed to machinery driven by a steam-engine or mill,) possesses a two-fold advantage; that is, first, it turns on its axis against its work, and thereby produces a drawing stroke, with a much greater velocity than would be produced without rotation; secondly, the whole external line constituting the circular edge of the knife coming successively in contact with the skin (and, as before recited, the knife being hardened), it is found to keep its edge at least twelve times as long as the present knives which are made of malleable iron, for the purpose of preserving a rough edge, that being found to answer

answer the purpose of cutting better than a smooth one; and this effect is produced in my knives by the fluting, as before described, with a very great saving of labour and time.

GENERAL REFERENCES TO THE DRAWINGS.

Fig. 1 (Plate X.) presents a view in perspective of the machine complete for cutting of fur, &c. with a metal rake held by the hand. A A, &c. the framing generally. B, the rollers to which the skins are attached: the length of the said rollers is determined or governed in every machine according to the width of the skins intended to be cut; and the whole of the framing and rollers in the remaining Figs. 2, 3, 4, and 5, to avoid repetition, are distinguished by the same letters. C, thin metal plate or rake placed on its edge, and kept parallel on the roller by the connecting rods, which are fixed into a shaft or axle working upon bearing, whereby the said rake is depressed or raised by the hand of the operator, as occasion may require. D, the knife fixed in the extremity of a short lever, which works into an universal joint, and preserves its parallel movement by sliding on a cylindrical bar fixed across the framing. E E, &c. the ratchet wheal, with levers and pall for communicating motion to the said roller B. F, box for receiving the fur when cut off the skin.

Fig. 2 exhibits a front view in perspective of machinery calculated to be driven by water or a steam-engine, or any other first mover. To render the whole apparatus clear and plain, the parts that are hid behind the roller and framing are represented or distinguished by the dotted lines. C, thin steel plate placed on its edge, and kept straight by being stretched or strained

in

in the manner of a saw for cutting marble, &c. D D, two knives fixed into the extremity of a lever projecting forward from the carriage to bring the knives to the centre of the said roller B. The fulcrum or centre of the said lever being fixed to the carriages (similar to the lever-beam of an engine) whilst the other extremity is connected to the carriage by the spiral spring represented by the dotted lines, as seen through the roller, which passes upwards by its elasticity, brings the contrary end of the lever containing the knife into contact with the skin, where it is prevented from either cutting through the skin or the roller by an adjusting screw acting upon the end of the lever, to which the said spiral springs are fixed, and counteracting their elasticity. E E, the carriage, part of which is seen above the roller and part behind, represented by the dotted lines, working on friction wheels, and is by its communication with the crank driven to and fro, or backwards and forwards, whereby the knives, as above described, are made to work in a parallel direction to the said plate or rake longitudinally on the roller. F, the fly-wheel, crank, and connecting rods. G, the connecting rod communicating to a bell crank, and from that by a lever to a ratchet wheel and pinion on the same shaft, shewn by the dotted lines through the framing, whereby the roller B is moved at each stroke of the knives about one-twentieth part of an inch. H, a compound lever, whereby the weight of the rake is occasionally taken off the skin.

Fig. 3 the perspective view of the small cutting machine as wrought by hand. C, wrought iron roller, working in brass bearings. D, the frame which keeps the iron roller in a parallel direction with the wood roller underneath, and by moving on its axles fixed to the framing,

framing, allows the said iron roller to be raised to change the skin, or pressed into contact with the sling, as the operator may find it necessary. E, the knife, in every respect similar to that described in Fig. 1, excepting the end of the lever working under. F, the bridge, which is raised or depressed at pleasure by either a wedge or screw, whereby the person working is prevented from cutting the roller. G, a box for receiving the fur.

Fig. 4 the perspective view of the machine for plucking the long hair out of the skins, particularly those where the fur is short. C, a small metal roller, supported by a bar, as represented by the dotted lines, D, roller, divided into two or more divisions, resembling a two, three, or more threaded screw, with the corners or edges first coming in contact with the roller C, rounded or taken off. E, crank, fixed on the axle of the said roller D, which is the first mover. F, lever and connecting rods, whereby the motion is communicated to the roller B by the ratchet wheel. G is a representation of the skin as fixed on the roller for plucking, which is performed in the following manner: the two rollers being turned in the direction of the darts, the roller turning with velocity brushes the long hair over the small roller between the roller C and D, when it is pressed or jammed, and plucked out; as but a small part of the roller D comes in contact with the small roller, the skin is not liable to be torn by the operation.

Fig. 5 is a view in perspective taken from the angle or corner of the machine. C, the crank or first mover, that communicates power to the parallel motion and carriage, which is omitted in this drawing, for the purpose of making it clear, but it is shewn separately in Fig. 6; whilst on the end of the shaft is fixed a worm, working into

Fig. 1.

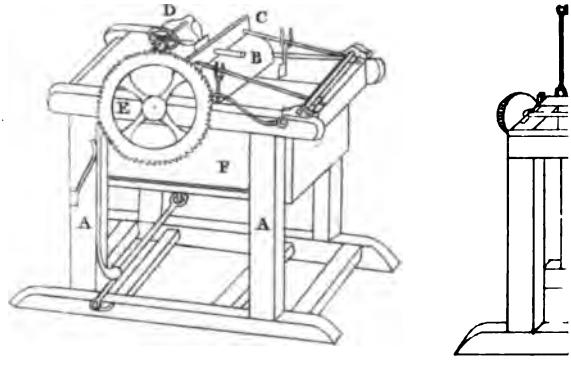
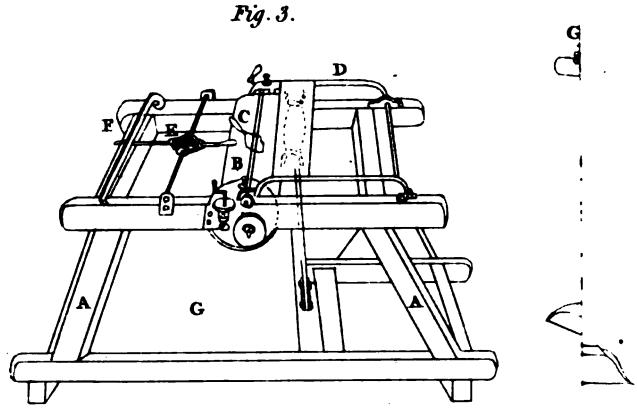


Fig. 3.



into and turning the shaft D; on which is fixed a second worm, working into a worm-wheel on the shaft communicating with the roller B, whereby the velocity is decreased in the proportion of 1 to 600, or to every revolution the worm C makes, the roller B moves nearly one-twentieth of an inch E F, four level geer wheels, for communicating power from the roller B to the rollers for moving the canvass, which should move with about twice the velocity of the roller B, or about one-tenth of an inch to every revolution made by the worm on the shaft C. F F, &c. five rollers for conducting and moving the canvass. G G, &c. four chain wheels, connected together to turn the rollers regularly. H, the drag or binding roller to prevent the canvass from slipping on the rollers. I, lever for pressing the said binding roller in contact, as occasion may require. J, large drum roller. K, iron roller, attached by connecting rods to the axle of the large roller, and prevented from slipping by working into geer with the spur wheels fixed to the side of the drum. L, chain wheels, whereby the power is communicated to drive it from the roller B. M, a small roller, supported by a second or a bridge of iron, or other metals, placed on its edge, and hollowed to receive a portion of the roller, and prevent the canvass from springing or bending the said roller.

Note. The canvass is only shewn as covering but a part of the rollers, on purpose to shew more distinctly each part of the machine, but otherwise it is to be as wide as the rollers.

Fig. 6 is the front view of the parallel motion carriage and knives, which work between the roller B and the lower large drum weeel F, and in a straight direction with the throw of the crank. A A, four radii or rods working on a pin or axle on each end, B, the connect-

ing links working upon pins at each end, and supporting the carriage by the middle joint. C, part of the connecting rod, by which it is connected to the crank, and is driven. D D, the carriage, supported by the parallel motion, as above described. E E, two circular knives fixed to the carriage, and regulated as described in Fig. 2, except that of turning on its axle, which is performed by simply fixing two pullies on the axles of the said knives, and fixing the middle of a piece of catgut on the said pullies, and the two extremities on the framing of the machine. Hence, as the carriage moves backward and forward, the catgut winds and unwinds itself off and on the pulley, and so on *vice versâ*.

Note. Figs. 1, 2, 3, are drawn to a scale of one inch to each foot; Fig. 4, one inch and a half to each foot; and Figs. 5 and 6 to a scale of three-quarters of an inch to each foot *.

Lastly, I do declare, that in the general description of the means hereinbefore given, and the particular drawings of the machinery by which my said invention is to be carried into effect, I have specified such constructions and parts in combination as I do most particularly approve for that purpose; but that it is also practicable, according to the intended scale of operation, the local situation of the work, and various other circumstances, to make the said machinery of different dimensions and structure of parts to answer the same ends; and that such changes may, when needful, be easily made by any competent workman from my said description and specification.

In witness whereof, &c.

* The drawings have been considerably reduced to suit the size of our plate.

Specification

Specification of the Patent granted to CHARLES HOBSON, CHARLES SYLVESTER, *and* JOHN MOOREHOUSE, *all of Sheffield, in the County of York; for a Method of sheathing Ships, roofing Houses, and lining Water-Spouts, with a Material not heretofore used for those Purposes.*

Dated May 18, 1805.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Charles Sylvester do hereby declare, that my said invention is described in manner following; that is to say: The material made use of for the purposes aforesaid is the metal called zinc, otherwise spelter, and such metal is cast into ingots, bars or pieces of any convenient size, shape or figure; after which the same is to be rolled between rollers, so as to convert it into plates of any required thickness. But it must be observed, that in order to prevent the zinc or spelter from cracking or breaking into pieces by the pressure of the rollers, the bar or piece previous to rolling must be heated by fire to a degree of heat between two hundred and three hundred degrees of the scale of Fahrenheit's thermometer, and kept at that heat till the metal is reduced to one-fourth of its original thickness; after which it may be rolled to the thickness required without farther heating. After this process the plates are found to be very hard, and difficult to be bent or worked; the said plates must therefore be annealed by again heating them to the temperature before mentioned, and the plates will then possess the tenacity and flexibility required for sheathing ships, roofing houses, and lining of water-spouts. The sheets of zinc or spelter, in the state last mentioned, may

be cut, bored, punched, or perforated like copper; and may be fastened with iron nails to ships or vessels having the usual treenails, bolts, or fastenings, but not of copper; or otherwise, in preference the nails may be of iron coated with zinc or spelter, or with tin. And it is hereby declared, that the best general rule or instruction for applying metals as fastenings for zinc or spelter sheathing, or for ships so intended to be sheathed, is to take that metal which is nearest in that power which chemists call Galvanism to zinc or spelter itself, and causes the least quantity of oxydation when made with zinc or spelter into a Galvanic pile. Iron and tin are metals of this description, and those among metals in general are to be preferred, of which a piece being laid in salt water, in contact with a piece of zinc or spelter, is found to produce the smallest change in the zinc or spelter in any given time. The sheets of zinc or spelter for roofing of houses or lining of spouts are to be manufactured, annealed, and fastened in the same manner, and with the same materials, or otherwise, when it is thought needful to fasten the plates more closely to each other. The same may be done by a solder composed of tin and zinc or spelter, or a solder of tin and lead, similar to that used by plumbers and other artists, under the name of soft solder.

In witness whereof, &c.

Specification

Specification of the Patent granted to WILLIAM SAMPSON, *of Liverpool, in the County of Lancaster, Wheelwright; for certain Improvements in the Application of Power employed mechanically, especially as adapted to the Use of Cranks and Fly-Wheels, or other Contrivances producing equivalent or similar Effects.*

With a Plate.

Dated February 12, 1806.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said William Sampson do hereby declare, that my said invention of certain improvements in the application of power employed mechanically, especially as adapted to the use of cranks and fly-wheels, or other contrivances producing equivalent or similar effects, is particularly described and ascertained by the following description thereof, together with the drawings of the same in the margin hereof.

This invention is distinguished by various advantageous dispositions of mechanic agency. The improvements principally consist in the division of any power which turns a reciprocating axis between two or more arms intersecting that axis, and communicating their motion to corresponding cranks, wheels, or other suitable contrivances, for the purpose of uniting to work one and the same shaft; the arms by this combined process transmitting to such shaft, with great advantage, the power impressed on them; for the action of each arm assists that of the rest, and, if the power be equally divided between the two arms, the action of the one exactly balances that of the other. If (as exemplified in the marginal

ginal drawing, Fig. 1, Plate XI.) two equal and opposite transverse arms C and D, by means of two rods and cranks E and F, communicate any motion impressed on them (whether by impulse on A, or in any other manner) to a shaft G, and consequently to its attached fly-wheel H, a simple operation of this kind will be effected. The arm A being moved to and fro, the arms C and D will turn the cranks E and F, which again will turn the shaft G and fly-wheel H; thus one equable circular motion capable of being applied to various mechanical purposes is obtained by the joint action of the two arms C and D. The arms may also be made to act immediately with considerable advantage in some cases, that is, without being employed to turn a common shaft, the operation of each arm being balanced by that of the other or others. Their situation upon the axis may be varied indefinitely, according to circumstances. Quarter cranks, as I I, to act with correspondent ones by means of rods, may very conveniently be worked on the shaft G; also toothed or cog wheels, as K, or any other suitable machinery.

If, as in the drawing Fig. 2, a second shaft M be added to the first, now designated N, and they be made to communicate with each other by means of four additional cranks O on each, with proper connecting rods between them, a farther improvement will be obtained; the shaft nearest the axis of primary motion receiving therefrom the impulse, transmits it through the additional rods and cranks to the second shaft, to which is transferred the fly-wheel H. Or, instead of two shafts in this form, two shafts, both similar to N, may be used, each standing in a line parallel to the axis, which is suitably lengthened out, and equally works both shafts by means of their respective

spective arms C and D, and rods and cranks E and F. The four additional cranks on each shaft, with their connecting rods, establish the communication between them laterally instead of longitudinally; a fly-wheel, as before, is attached to one of the shafts, which thus finally receives the whole impulse transmitted by the axis, but one half of it in a direction at right angles from the other.

These compound machines may be considerably varied, and more shafts and arms, and more or fewer cranks, may be used, according to the nature of the work to be performed, and other circumstances.

Machines constructed upon any of the principles may be made of any size, and worked by any power capable of giving sufficient impulse to the axis, or different machines, impelled by different forces, may be made to act at right angles to each other, or otherwise, so as to combine in one common operation. Small machines may be worked with great advantage by a handle suspended from the axis, and aided by a pendulum. The motion of the shafts in one uniform direction either way is preserved by means of proper ratchet wheels and catches; horizontal wheels are to be preferred when the shaft is vertical. The machines particularly described may be worked in any position; upright, as in the drawings, or reversed, or laid laterally, with little or no alteration of their relative parts; the ratchet wheels must of course be suited to the change of position. The improvements generally are capable of a great variety of application; even the relative situation of the different parts of the machine, Fig. 1, might be variously changed, and the power transferred in any direction. The power may also be divided variously, and its balance still preserved entirely or partially, as the case may require. If it be originally

ginally impressed by alteration on two opposite arms turning on one axis, (as A and B,) it will act with the greatest advantage. It must be evident, that machinery constructed upon these principles of improvement is liable to a very small degree of friction.

In witness whereof, &c.

Specification of the Patent granted to THOMAS JAMES PLUCKNETT, *late of Butt-lane, Deptford, in the County of Kent, Gentleman, but now of the Parish of Christ Church, in the County of Surrey; for a Method of mowing Corn, Grass, and other Things, by Means of a Machine, moving on Wheels, which may be worked either by Men or Horses.* Dated August 23, 1805.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Thomas James Plucknett do hereby declare the principle of my said invention to be as follows: By means of a pair of common carriage wheels, fixed at the ends of an iron axle, so as by the going of the wheels the axle is turned in collars; to which axle is fixed a cog wheel, which communicates with two others, by which means it turns an upright shaft, to which a circular steel cutter or knife is fixed under the axle, higher or lower, according to the use to be made of it; which cutter or knife traverses round the upright shaft going through the centre of it; the machine is conveyed along by two arms, in like manner as a common hand cart; and which said invention I do particularly describe and ascertain in manner following; that is to say: The machine is about two feet six inches wide between the felly of the wheels, and

Fig. 1.

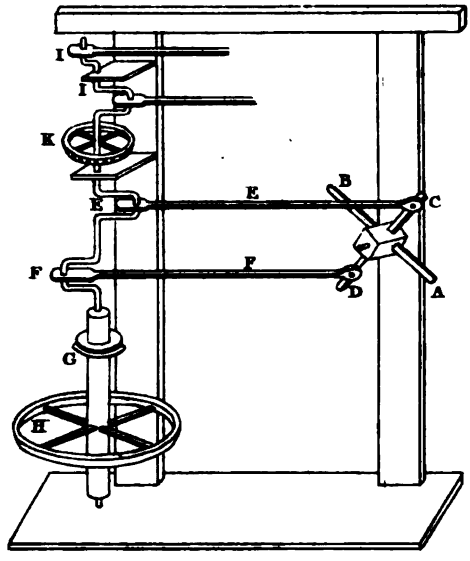
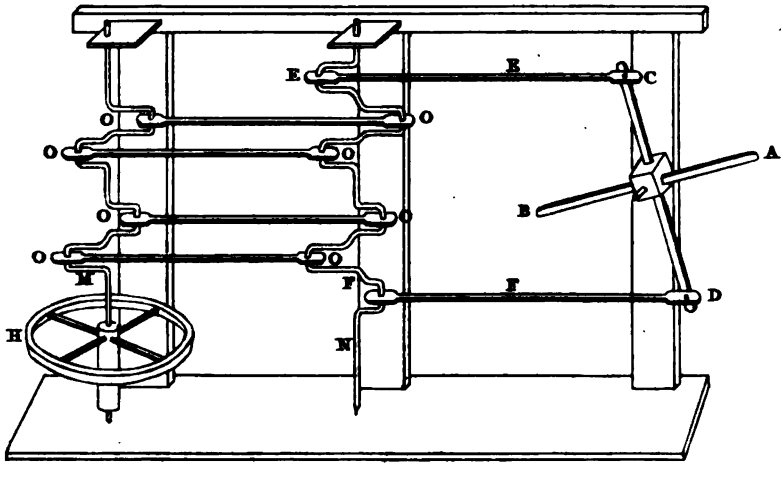


Fig. 2.



and is made as follows. Two shafts, about two inches square and about seven feet long, are framed with a cross bar before the axle of the wheels about ten inches, and another behind the axle of the wheels about two feet six inches; below and directly under the axle is a piece of plank, about five inches thick and ten inches wide, fastened to the shafts with four (more or less) small bolts in each, and through chocks, five inches (more or less) deep under the shaft. The wheels are about four feet six inches diameter; the stock and box are cast-iron or brass, or any fit material, and are made as follows: the inside of the box is octagon, to prevent the wheels turning on the axle; or, if the box is made to turn on the axle, there will be less friction. To the outside of the box there is a flanch, about four inches or more, as many as may be necessary; by the side of which are fitted the spokes, which are likewise placed by the side of each other within the flanch. Then a shifting flanch, with a hole made for the box to pass through, is with a screw-bolt through each spoke and both flanches, fastened by means of these bolts to the fixed flanch, which is cast or wrought to the box. In consequence of these flanches and bolts you have no wood, stock, or nave, and the spokes are more secure, and fit to be exposed to the weather without injury. The other parts of the wheel are made in the usual way; the axle is made of iron or other strong metal, with octagon, square, or other shaped arms to fit the cast-iron or brass boxes, with octagon, square, or other shaped holes. On the axle are turned round collars at the breadth of the shafts, where there are fastened proper coupling irons (or of brass, or other fit material) for the axle to work in, one over the other; the axle is properly secured by means of screw-bolts or other fastening

tening through each coupling iron, so that the axle is fitted on the upper side of the shafts, by which means the weight of the machine is hung by or upon the coupling irons where the axle turns. On the axle is fitted a tooth-wheel, of about twelve inches diameter, which works in a pinion of about three inches and a half diameter fitted to the plank under the axle. Under this pinion, on the same spindle, is fixed a tooth-wheel, of about twelve inches diameter, which turns the knife-pinion. This pinion is so called because it has a hole, about three-fourths of an inch square, through it; and by means of these wheels the knife makes near eleven revolutions to one of the carriage wheels. The knife or cutter may be made of any diameter agreeably to the power you mean to apply to the machine; for a man's power about one foot eight inches is sufficient for any purpose; if for a horse, about three feet. The knife is a wrought or cast steel plate, circular, of about one foot eight inches diameter; the whole of the circumference is made perfectly sharp, and fitted on a spindle, which fits the square hole through the knife-pinion; the upper end of which has a screw, to adjust the knife to any height above the ground, and as it revolves parallel to the ground, if it meets, as it is carried along by the carriage, with any obstruction, it will immediately fly up through the hole above described without stopping the machine, and adjust itself again as the obstacle is removed.

Leaders to take up the Grass or Corn where it is laid with the Wind or otherwise.

As this machine is driven before the man or horse, there is fitted an iron or other metal stay, about half an inch diameter, leading from the fore end of each shaft down

down to the knife, where they are screwed to a piece of iron or other metal, in the form of a cross, or any other proper shape, whose ends are above the length of the diameter of the knife, one on each side and one behind. On this cross is fixed a centre for the knife to work on, by which means the knife is fixed at the under side as well as through the square of the pinion; it likewise secures the ends of the leaders down to the knife. In the front of these leaders project two, three, or more horns, of iron or other metal, about two inches long, or more if necessary, parallel to the ground, divided between the length of the leaders; the upper edge sharp, (or otherwise, as may be necessary,) to cut where it meets with any grass or corn entangled together. By means of the leaders and horns all grass and corn will be taken up and led to the knife, and not missed or passed over. The ends of the shafts make the handles for the power (as man or horse) to drive the machine before them.

The above description is for the machine to be so made that all the work is hung to and before the axle if it is necessary. The whole may be placed above the axle, as circumstances may require, where it is to cut very high from the ground; in that case the knife or cutter is to be taken out of the socket-pinion, and replaced in the under side of the axle, as before described.

Note. This description is for grass, corn, &c. &c.; but the machine may be made of any other dimensions, as circumstances may require.

In witness whereof, &c.

On the Nature and Properties of Manures, and the Mode of preparing and applying them to various Soils. By ARTHUR YOUNG, *Esq. F. R. S.*

(Continued from Page 193.)

CHAPTER XI.

Sea Weeds.

WHEREVER these are to be had, the farmers use them with uniform success. Sixty years ago the use was so great and decided in Scotland, that land, which without weeds would let at only 10*s.* *per* acre, let with it from 20*s.* to 40*s.* The best sort, and the most durable, is cut from rocks at low water *. In Caithness they form composts of it with earth, kept from six to twelve months. In the Hebrides it gives only one tolerable crop. And in Argyleshire they found most advantages on peat moss or boggy land †. But Mr. Somerville remarks, that on the coast of Haddington they use it fresh, in which state one load is of more service than two which have fermented in a heap. Nearly the same effect has been experienced in the Isle of Thanet. It will be found the same every where, and with nine substances out of ten. Such remarks combine with the question of long and short dung.

CHAPTER XII.

Pond and River Weeds.

Two or three very intelligent farmers in Norfolk have found great benefit in cutting these weeds just before the last ploughing for turnips, and spreading them as a manure for that crop. That great cultivator Mr. Coke thus

* Maxwell.

† Statistical Account of Scotland, Vol. VIII. XII. XIV.

clears

clears his lake every year. A correspondent of the Bath Society, Mr. Wagstaff, values them load for load as dung; and in another trial the following barley superior to that which followed dunging for turnips *. I have not known composts being made with them; it would be an absurdity.

CHAPTER XIII.

Hemp and Flax Water.

In Yorkshire they observe that the grass grows doubly where flax is grassed, which shews that all the putrid water of the pits should be used as manure †.

The very ingenious Mr. Billingsley carted flax-water on his land, and the effect was extraordinarily great; superior to animal urine ‡. These very valuable hints should be pursued. And wherever convenient ponds or reservoirs are on a farm, one at least should be half filled in summer with green weeds for the putrid water, which would soon be the result.

CHAPTER XIV.

Burnt Vegetables.

Under the head of Paring and Burning, some explanations relative to this subject were given; and it is to be remembered, that the qualities of the ashes of all burnt vegetables (except marine plants) have a pretty near resemblance; some abounding with larger, and others with smaller portions of alkaline salts. There is, however, a circumstance of practice, which has taken place in some districts in Lincolnshire, which should be mentioned; and that is, the burning straw upon turnip-

* Bath Society's Papers, Vol. IV. V.

† Middleton's Ann. Vol. XIV.

‡ Report.

land

land just before sowing. From three to five tons *per* acre are evenly spread, and then set fire to; it has been compared with, and found superior to, common dunging. Other facts which combine with this, are the practice in the fens of Cambridgeshire, &c. of burning very stout oat-stubbles reaped high, as a preparation for wheat, which is found both to clean and improve the land; and that of burning straw in the Lincolnshire way for turnips also, which is the common husbandry in the Pyrenees. It is sufficient to mention these practices. Every enlightened reader will see the necessity of many experiments carefully made before conclusions should be drawn.

CHAPTER XV.

Ploughing in Green Crops.

This husbandry has for ages been practised in this kingdom, and is common in many others. Yet the reports of individuals of their success have not been uniform; many have found little advantages from it. The practice however keeps its ground in every country, and is found by some persons singularly beneficial. In all such cases it is absolutely necessary, when every circumstance of a trial be not carefully registered, to consider only the results which are successful.

If growing vegetables turned down prove in many cases to be good manure, it can be only from their fermentation gradually converting them into the food of plants. And in the cases where they do not operate, it must necessarily be from some circumstances of bad management or inattention, which counteract the obvious tendency of the substances to that conversion which is necessary to enable them to act. We have already seen that every vegetable particle under the surface dissolves and

and yields gasses, which may either be taken up by the roots of plants, or carried away by the atmosphere. But crops may be so imperfectly buried as to convey those gasses into the air, instead of retaining them in the soil. If this point be not carefully attended to, failures may reasonably be expected. What has been observed concerning long fresh dung is applicable here; and it accounts for variations in the results reported. The only way of proceeding is to roll down the crops with a barley-roller, and add a skim-coulter to the plough, going in the same direction as the roller, to plough six inches deep. To have no other successive tillage than scuffling shallow on the surface. This is an operation, the effect of which depends exceedingly on the execution. It usually answers better for a summer's sowing, as of turnips, or early winter tares, than for late autumnal sowings.

GENERAL REMARKS.

Here are fifteen sorts of manure, which are usually to be procured on most farms. In the calcareous class, lime, marle, chalk, or lime-stone. Sand or clay. Burnt earth. Paring and burning. The farm-yard and sheep-fold; and ploughing in green vegetables. The dung of the farm-yard may, on all arable farms, manure from one-sixth to one-fourth of it, or from 17 to 25 *per cent.* By a proper course of crops and layers, a certain portion may be pared and burnt; and at least 10 *per cent.* manured by ploughing in green vegetables. A good manager may, by these three exertions, manure more than one-third of his arable land every year; which, with a right application of calcareous manures, will keep any land in heart, and regularly in a state of improvement,

PART II.

Of purchased Manures.

IT will tend to shorten the enquiry, if these be divided into those of the three kingdoms of nature.

1. Animal.
2. Vegetable,
3. Fossil.

The situation of a farm must necessarily govern all exertions in the purchase of manures. But there are few spots where something may not be done in this way.

CHAPTER I.

Of Animal Manures.

Under this head may be included,

1. Night-soil.
2. Bones.
3. Sheep's-trotters.
4. Hair.
5. Feathers.
6. Fish.
7. Tallow-chandler's graves.
8. Woollen rags.
9. Currier's shavings.
10. Horn shavings.

I shall first give a view of the common practice in the use of these manures, and then consider them collectively under the heads pointed out by the Society.

§ 1.—*Night-Soil.*

This manure is to be had in quantities only in the neighbourhood of cities. In the vicinity of London it is largely used; and I have had during several years much experience in its application. The common quantity for an acre is about two hundred bushels, but I have tried it in larger portions. It is the best of all manures; and, if dry, the cheapest. It does equally well on all soils, and

for

for all crops; but the most profitable application in which I used it has been for grass lands, and spread after clearing away the hay; but I have spread it in all seasons, and found the benefit immense. If kept dry it is worth 3*d.* *per* bushel, and may be had at that price. But if quite pure, and in powder, I would give 6*d.* *per* bushel for it, rather than forego the use. It is very durable in effect. Of all other manures it is in a state of powder the best for delivering by drill cups, with turnip-seed, in the manner lately practised by Mr. Coke, at Holkam, with rape-cake dust.

§ 2.—*Bones.*

Used to a considerable extent about London. The quantity five or six loads *per* acre, to the amount of two hundred and fifty to three hundred bushels, but varying according to the practice and opinions of individuals. They are collected, broken, and boiled for the grease, and then sold to the farmers. Some years ago they were to be had for 1*d.* *per* bushel, but have risen to nearly treble that price, and in some places even more. I have used them largely, and found them excellent for potatoes; they do best on strong soils, and their duration exceeds that of all other manures. The effect has been seen for above thirty years. The dust, the refuse of bone-manufacturers, is used also to excellent purpose. This is well adapted to cup-delivery in drilling any sort of seeds.

§ 3.—*Sheep's Trotters.*

These are a powerful manure, and usually sold by the quarter, with feltmongers' cuttings. The price some years past was 4*s.* *per* quarter; but in the scarcities they advanced, and have not again fallen. Four or five quarters *per* acre is the common dressing; but I have known

eight spread. The effect is great. They should be ploughed in not less than six inches, with a skim coulter; or vermin and dogs will be attracted.

§ 4.—*Hair.*

Hogs' hair is sold in great cities from 1*s.* to 1*s.* 6*d.* *per* bushel, pretty well squeezed into the measure; but depending, as in all uncertain measures, on the attention of the purchaser: from sixteen to twenty-five bushels *per* acre, the common quantity.

§ 5.—*Feathers.*

These are found to be a powerful manure. I have known them bought at 1*s.* 6*d.* *per* bushel, lying close, in a partly-clotted state; and twenty-five bushels an acre spread with much success. But it is registered that ten bushels an acre yielded forty-eight bushels of white wheat. The same land unmanured gave but twenty-eight *.

§ 6.—*Fish.*

Every sort of refuse fish is one of the most effective manures that can be carried into our fields. The whale blubber-offal is every where applied to this use, and never fails of giving great crops wherever spread. The refuse of the pilchard fishery in Cornwall deserves the same remark. They are dressed with bay-salt; the refuse sold at 6*d.* *per* bushel; and immense crops of barley, even to ninety bushels *per* acre, are said to have been gained by their application †. Herrings in a plentiful take have been applied to the same use in Scotland. In Dorsetshire, Mr. Davis, of Swire, spread them *fresh*, at 1*s.* *per* load, thin over a field, and ploughed them in for wheat.

* Bath Memoirs, vol. I. † Report.

The

The crop was so rank that it was entirely laid before harvest *. And in the fens of Cambridgeshire, Lincoln, and Norfolk, the little fish called sticklebacks periodically swarm in the rivers to that degree, that a labourer has earned 4*s.* *per diem* by selling them to the farmers at ½*d.* *per* bushel. They are now risen to 6*d.* and 8*d.* and great sums are thus invested for forming composts. Major Cartwright, near Boston, found them to exceed whale refuse, probably because used in a fresher state.

§ 7.—*Graves.*

Tallow-chandlers' refuse is purchased at from 2*s.* to 5*s.* *per* cwt.; and from ten to fifteen cwt. are commonly spread *per* acre. I have seen remarkable effects from them in turnip crops, on poor sandy soils. Dr. Wilkinson, of Enfield, found them far superior to dung for that crop.

§ 8.—*Woollen Rags.*

The price of these have varied of late years considerably; from 5*s.* to 7*s.* 6*d.* *per* cwt. Chopping them into small pieces is 6*d.* *per* cwt. From five to twelve cwt. have been used. It has been an observation of the Hertfordshire farmers, that they do best on dry and sandy lands. They not only, in common with all animal substances, become the food of plants, but also attract and retain much moisture from the atmosphere. Dr. Cullen found that they have a sensible effect for six years.

§ 9.—*Curriers' Shavings,*

And furriers' clippings are bought at London at about 1*d.* *per* bushel, but the price varying with *times.* When corn sells well, these and other manures are eagerly sought for, and at high prices; but in bad times the de-

* Report.

mand is slack, and the price falls. Thirty bushels *per* acre are a common dressing. They do best on dry soils.

§ 10.—*Horn Shavings.*

These also are bought at about 1*d.* *per* bushel, and thirty sown *per* acre. They are almost equally applicable to all soils, but do best in wet seasons. The coarser sorts are cheaper, but inferior in effect, though more durable.

§ 1.—*The Nature and Properties of these Animal Substances.*

All animal substances are resolvable into hydrogen, nitrogen, oxygen, carbon, phosphorus, and sulphur; that is, they contain the principles which by every consistent theory of vegetation are necessary to the food of plants, already supported by earth, air, and water, the two latter certainly, and probably the former likewise, formed of these simple principles. The practice of the farmer here goes hand in hand with the philosophy of the chemist; for every husbandman knows, or ought to know, that every animal matter whatever will fertilize his fields.

The nature of these bodies can scarcely be mistaken; and it should be more generally known, that it is the same in all. When any of them are found more *rich* than others, it depends merely on a greater ease of dissolution; some run into fermentation sooner than others, but they all ferment; and by that intestine motion produce more or less of the same principles.

The difference in their active properties depends on this circumstance. Bones will last twenty years; but urine begins to act immediately, and has a short duration: but every one agrees in the main point, of yielding the food of plants.

§ 2.—*Preparation; State; Application.*

There is but one point here to be considered consistently with any degree of brevity; and that is, the question which arises with some, whether to apply them immediately to the soil, or prepare them by fermentation in a compost or dunghill?

The common practice with much the greater part of these manures is to apply them in the state they are purchased; and this conduct combines with a question before discussed, of fresh and rotten dung. If every particle is sure to dissolve in the soil, and by dissolution yield those first principles of these bodies just recited, for what purpose should a previous fermentation be excited to produce gaseous matters evaporable in the moment of their production, and, if not buried, carried off by the atmosphere?

Horn shavings in a heap would become mucilage, yet the best farmers all sow them without preparation; and the more the subject is examined the wiser will their conduct appear. All turns on the dissolution of a single particle—a point of vast importance, which pervades and ought to govern the whole theory of manuring.

The result will be found consistent with the more general practice. All these substances should be applied to the soil as soon as the farmer's convenience and the state of his fields will permit.

§ 3.—*Season; Quantity; Soil.*

The farmer, by purchasing these manures in January, has or should have a power of storing them free from rain or wind, and consequently of using them at the season that best suits his purpose. The only one *properly* applicable as a *top dressing*, is night-soil dry and in powder;

der; all the rest should be ploughed in as soon as spread. There are authors that recommend sowing all or most manures in this method, which is consistent only with the supposition, that as they dissolve the atmosphere does not carry them away. The absurdity is self-evident. In proportion to the ease and susceptibility of fermentation, they ought to be spread as soon as may be before the seed is sown. The *quantity* commonly applied has been mentioned under the respective heads.

As to *soil*, all animal substances act as manures powerfully on all; but the fermentation and consequent dissolution will depend very much on its being loose, friable, and neither quite dry nor very wet. On heavy clay soils they will not act with the same energy as on loams, good sand, and the drier calcareous earths. But bones, having a mechanical effect as well as a fertilizing one, are excellent on such land.

CHAPTER II.

Of Vegetable Manures.

The manures from the vegetable kingdom which are most commonly applied are,

1. Wood-ashes.
2. Peat-ashes.
3. Coal-ashes *.
4. Soot.
5. Peat-dust.
6. Potash waste.
7. Sugar-bakers waste.
8. Tanner's bark.
9. Salt-dust.
10. Rape-cake.

* The supposed vegetable origin of coal would not justify this classification; but it will conduce to clearness to arrange all ashes in the same division.

§ 1.

§ 1.—*Wood-Ashes.*

From several experiments which I made in consequence of Mr. Hazenfratz starting a query, whether alkalis were a manure, I found that pearl-ash is a very powerful one; and that it had also the remarkable property of acting on charcoal (though not by fusion *) by mere mixture and solution in water. The nature of wood-ashes is well known; and wherever tried they have proved a valuable manure. They evidently act by their alkakine salt as well as by classing among the substances which have passed the fire; the effect of which operation in every degree of heat (small as well as great) is by no means well understood. According to Mr. Kirwan, they contain some phosphorated selenite; common salt and Glauber's are also found in them in small quantities; all which in a small dose accelerate putrefaction. They attract carbonic acid from the air †. I have had experience of their use on gravel and loams both dry and wet, and never used them without good effect. The spring is the proper season, and succeeding rain of much importance. Forty bushels *per* acre the common quantity.

§ 2.—*Peat-Ashes.*

In most countries where peat-bogs are found, the ashes are a common manure. Their value usually depends on the blackness and density of the peat that is burned. Those of the Newbury peat are the most celebrated, and ten or twelve bushels an acre is a common quantity: whereas in other countries twenty to forty have been usually applied. This difference is the result of the component parts of the ashes. One hundred grains of the Newbury contain, according to Mr. Davy,

* Rouelle, Fourcroy. † Priestley.

Oxyd

Oxyd of iron - - - - - - - - -	48
Gypsum - - - - - - - - - -	32
Muriate of sulphur and of potash -	20
	100

Where these ashes are used with great success, there is probably a deficiency of iron in the soil. Similar is the result of uncommonly ferruginous peat-ashes, in Bedfordshire, when used on the chalk hills of Dunstable.

The great effects which on some soils attend the use of five or six bushels *per* acre of gypsum, prevents us however from concluding that the whole benefit of the peat-ash is from the oxyd of iron; this will depend on the soil which may possess iron enough (all have some); and in that case the gypsum may be important. In the Newbury peat-ash no alkaline salt is found. Lord Dundonald says, it is not found in any; yet some authors have told us that it contains a twenty-second part of fixed alkali; but, although peat-ashes contain no alkali, the ashes of surface-turf on a peaty soil do contain them, of which many cases have occurred; amongst others, see Brussels Memoirs. Their effect is greatest on dry friable soils. On stiffer ones the quantity used is larger; and on some clays they have been tried with very little, if any effect.

§ 3.—*Coal-Ashes*

Are used all over the kingdom. The quantity is from fifty to two hundred bushels *per* acre. All sorts of ashes have been found most effective when spread on clover, sainfoin, or other *seeds* in the spring. They are good also on grass lands, and are by many used on green wheat. The effect is considerable in Hertfordshire, of fifty

fifty to sixty bushels on dry chalk lands. They answer best of all on dry, sound, rich loams; but on clays, and wet gravels and loams, they make a very poor return. Mr. Dau, of Kent, compared the finely-sifted ashes of London with the coarse ashes and cinders of Chatham barracks, not kept under cover, and these last much exceeded the others in value. These ashes contain carbon, and hydrogen, a great quantity of carbonic acid gas, and some iron. Our knowledge of them and their properties is very imperfect.

§ 4.—*Soot.*

This substance is composed of oil, volatile alkali, carbon, and earth; consequently of hydrogen, nitrogen, carbon, and phosphorus. No wonder, therefore, that it should be found a very powerful manure. All its component parts are also in a state of such minute division, that they are not only washed into the soil by a single shower, but convertible immediately into the food of plants. The effect is visible after rain in a few days. Twenty bushels *per* acre are the more common quantity, applied in the spring to green wheat or clover. The effect is great on most soils, least upon strong or wet clay.

§ 5.—*Peat-Dust.*

If the peat be black and solid, it is resolvable into a greater proportion of hydrogen gas than most other substances. And as it will hereafter be shewn, that this gas is one of the most powerful manures which can be applied, it is consistent with chemical principles that it should operate as a strong manure. Many peats contain also much iron; and, consequently, if the soil be deficient in that substance, it must be farther beneficial. Another quality is its strong attraction of humidity, which

renders it very advantageous on dry sandy soils. The use of it as a manure is by no means so general as it might be. But in Bedfordshire, and the neighbouring part of Hertfordshire, this application of a very ferruginous peat is well known and practised.

Some scattered experiments have been made which are interesting *. Mr. Farey asserts it to be the best possible dressing for onions.

§ 6.—*Potash Waste.*

The makers of potash, if they do not farm themselves, sell large quantities of their waste, which consists of lixiviated wood-ashes. They are not a powerful manure; and no wonder, after the alkaline salt is extracted. Ten loads an acre, or three hundred and fifty bushels, are a common quantity. They do good on low meadows, and in general on all grass lands.

§ 7.—*Sugar-Bakers' Waste.*

I never tried this manure, but I have been informed that it is a powerful one. There are not more than five or six places in the three kingdoms where it is to be procured. I have not yet found that sugar itself acts as a manure, which, however, demands farther trial, as it ought to be powerful.

§ 8.—*Tanners' Bark.*

The tanning principle is, I believe, in all cases hostile to vegetation. Whatever benefit is derived therefore from the application of tanners' waste, must arise either from the lime or the animal impregnation. I have tried bark more than once, to the quantity of two or three waggon-loads; but I could not perceive the smallest be-

* Annals, vol. XX. Wright's Husbandry, vol. III.

nefit

nefit derived from it during two years. Whether or not it afterwards yielded any, I am not able to speak; and it would depend on the manures afterwards added. If useful any where, it ought to be on calcareous soils. Mixed with lime, it has been found useful in Warwickshire *. With Mr. Townley it did mischief. Land without manure gave 134 bushels; with stable-dung 315; bark 35 †.

§ 9.—*Malt-Dust.*

There is no part of the kingdom in which this substance is not applied as a manure, and every where with success. Besides this general experience, a few particular experiments have been made on it. Mr. Flower, of Northamptonshire, compared, 1, malt-combs, 2, ground bones, 3, horn-shavings, 4, stable-dung, 5, salt, 6, Van Haake's powder, on grass land. The order of success was, 1, malt-combs, 2, stable-dung, 3 and 4, horn-shavings and bone-dust, which were equal: salt and Van Haake good for nothing ‡. Mr. Middleton, upon a tenacious loam on a yellow clay bottom, tried from fifty to sixty bushels *per* acre, and found the benefit considerable, ensuring one large crop. But on meadow with hay, at 5*l.* a ton, it only repaid the first cost §. Lisle, who was a truly practical farmer, used this manure for many years. Eighty bushels an acre exceeded dung on clay land for wheat, and gave an improved barley crop after. It gave a great improvement on cold grass land also. The *kiln* dust that comes through the hair cloth was used; the *tail* dust was applied to feed pigs. From twenty to forty bushels *per* acre are applied in Hertfordshire. I have used it various times, and on several soils, and always with success.

* Report. † Farmer's Magazine, vol. IV.

‡ Report. § Society's Transactions, vol. XVII.

The effect may be attributed to two circumstances. First, it has undergone heat which we have found may have effect, the causes of which are not well understood. Secondly, and chiefly, it contains portions of the germinating parts of the barley in the saccharine state; and containing hydrogen and carbon, cannot fail of yielding the direct food of plants.

§ 10.—*Rape-Cake*

Has been in common use in Norfolk for above fifty years, and the quantity very generally, while it was to be had at 4*l.* and 4*l.* 10*s.* *per* ton, was half a ton *per* acre. But it has of late years been double that price, and the quantity *per* acre has been lessened in proportion as the price advanced. A ton is now applied to three acres; and by a very useful practice of Mr. Coke's, (that of drilling it in *powder* with turnip seed,) he makes a ton do for five or six acres. Before this invention it used to be broken into very small pieces, and in that state ploughed in about six weeks before the seed earth, to give it time to dissolve in the soil. Ploughed in with wheat seed it hath been found more forcing to the crop than either dung or fold; but the turnips after the wheat have not been so good as after those manures *. The Marquis of Exeter † compared two quarters *per* acre of rape dust, at 20*s.* *per* quarter, against two dressings, one of yard dung, the other of lime; the soil a creach lime-stone; the rape dust superior. Malt dust and soot for wheat were equal; but rape dust better than either. The operation of this manure is assignable to a very obvious theory. All oleaginous bodies abound greatly with hydrogen and carbon, their utility consequently must be great.

* Annals, vol. II. † Ibid. vol. XXIX.

TO BE CONCLUDED IN OUR NEXT.

Description

Description of an improved Door-Latch.

Invented by Mr. JOHN ANTIS, *of Fulneck, near Leeds.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was voted to Mr. ANTIS *for this Invention.*

I DO not doubt but that the Society are persuaded of the necessity of having a door-latch superior to, and not so liable to be out of order as those hitherto in use, in the door-locks of dining-rooms, &c. Some time ago I made an attempt to contrive such a one, which I fixed into a small box by itself; I have now tried it for some years in my own house, during which time I never found occasion to clean or to oil it. I at that time thought there would be a difficulty to introduce it into a mortise lock, in such a manner as to place the nobs and the key-hole symmetrically. That difficulty I have now overcome.

My object has been to contrive a simple latch, as much as possible without friction, not more expensive than those hitherto in use, and capable of moving smoothly and easily without the necessity of cleaning and oiling, as long as the metal will last of which it is made. How far I have succeeded, I leave to the decision of the Society.

REFERENCES to Plate XII. Fig. 1.

A, shews the hole for the handle, which moves the follower and latch. B, the follower which draws back the latch on turning the handle either way. C, the latch.

D,

D, the longitudinal spring, which throws out the catch of the latch when the hand is withdrawn. E, the small bolt, to secure the door internally. F, the key-hole, the bolt of the lock of which is not shewn, being placed above the key-hole.

Description of an Improvement in Time-Keepers.

Invented by Mr. J. WATKINS, *of Giltspur-street, West Smithfield.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Thirty Guineas were voted by the Society for this Improvement.

THE principle of the improvement is to reduce friction, it being the greatest enemy to machinery in general, but more especially to such as is intended for measuring time; for, while my plan retains every advantage of the best similar improvements hitherto made, the friction of the most essential parts is reduced full one half, consequently better performances may be expected, and the machines be more durable.

I have sent a sketch of the dip or depth that rollers of the same size take into a wheel, by placing them in different positions and describing the same angles.

I have by me, and belonging to the model I have sent, other wheels of the most eminent makers; such as Arnold's famous epicycloid wheel, and Mr. Earnshaw's; and by applying them to the machine, my plan is clearly proved to be preferable to any other.

Not

Not having sent you an explanatory or descriptive account of the properties of my model, for an improved detached escapement to reduce the friction in time-keepers for ascertaining the longitude at sea, I now take the liberty, for the information of the Society, to send you my opinion of the advantages which I think it possesses over any that have hitherto been made.

The good performance of time-keepers entirely depends on three things, *viz.* the escapement, balance, and pendulum-spring; and I am convinced, from the experience I have had in time-keepers, that a considerable share of the trouble attending the adjustment of them in different positions, arises from the general mistaken judgment in giving the impulse to the balance, also from not thoroughly understanding the properties of the pendulum-spring.

Observations on an improved detached Escapement for Time-Keepers for ascertaining the Longitude at Sea, on a Principle to reduce Friction.

The good performance of time-keepers for ascertaining the longitude entirely depends on the regular and uniform vibrations of the balance, which likewise depends on two particular parts of the machine, *viz.* that which is called the escapement, or the parts immediately connected with the balance to give it motion; and a proper compensation part to regulate itself in different climates; which two are the only parts now worth attention: for although it must be acknowledged, that time-keepers have of late been brought to very great perfection, yet I think it must be admitted, that they are susceptible of still greater improvement; and, considering the amazing service they have rendered to navigation, every possible encourage-

encouragement ought to be given to render them still more serviceable.

The escapement is composed of two distinct parts of action. First, that which the wheel locks, or rests upon, while the balance is in motion; and, secondly, that which gives the impulse to the balance after it is unlocked: and those that are made with the least friction are undoubtedly the best.

The contrivance of locking the wheel on a spring, if properly made, is, I think, as perfect as human invention can produce; but the mode of giving motion to the balance I by no means think is so: for when you compare the manner in which the balance of a watch is kept in motion with the pendulum of a clock, you must give the preference to the latter. The former, moving on opposite centres, as soon as they come in contact, oppose each other, till they come into a straight line, and in leaving each other occasion considerable friction up the side of the tooth, which action not according with the motion of the balance, greatly retards its progress.

The manner in which the pendulum of a clock is kept in motion is very different; for, as soon as the wheel is unlocked, it receives the impulse from what is called a crutch, which being suspended on the same parallel of suspension, describes exactly the same circle, and consequently there cannot be the smallest friction whatever. After many and various trials which I have made to produce the same principle in watches as is in clocks, I found I could not give the impulse from its own centre without introducing other pieces which would counteract the good effect derived therefrom; nevertheless, I was determined to approach as near to it as possible, and to employ no more parts to produce the effect than are used in those of the common construction.

In

In order to do this, I made a horizontal contrate wheel, and cut teeth on the uppermost rim of it; I introduced a piece of brass inside it, just free of its bottom, on which I placed, half-way between the extremities and centre of the wheel, the axis of the balance, on which I put a round piece of steel with a notch in it, called the impulse pallet, and nearly half the size of the wheel's diameter. After the wheel is unlocked in the usual way, with a spring, the pallet receives a tooth on the point of the notch, which forces it round in a circular direction, nearly corresponding with its own; consequently there cannot be so much friction, as the teeth do not take above half the usual depth into the impulse-pallet, in which case jewelling will be quite unnecessary; the machines must last longer, and as good performance depends on the uniform motion of the balance, there is not the smallest doubt but, if justice is done in executing the other parts of this escapement, and a proper compensation for heat and cold, they will perform more accurately than any that have been hitherto invented; but in case any doubt should arise on my plan of placing the impulse-pallet in the mid-way, between the extremities of the wheel and its centre, I beg leave to offer this single proposition, the propriety of which will not admit of the smallest doubt, *viz.* If it be perfection to give motion to a body acting on pivots from its own centre, the nearer you approach to that centre the less friction there will be.

REFERENCES to Plate XII. Figs. 2, 3, and 4.

Fig. 2, a perspective view. A, the circular frame of the machinery. B, the pendulum-spring. C, the balance. D, the axis. E, the cock in which the upper pivot of the axis runs. F, the impelling pallet, on the axis of which is a small unlocking pallet. G, the detent

and unlocking spring. H, The axis of the scape-wheel, supported by a cock below it. I, the scape-wheel. K, the cock which supports the lower axis of the balance and scape wheel. L, the screw for adjusting the locking of the wheel.

Fig. 3, a bird's-eye view. A, part of the circular frame of the machinery. C, the balance. M, the small unlocking pallet above the impelling pallet F. G, the detent and unlocking spring. I, the scape-wheel. K, the cock which supports the axis of the balance and scape-wheel. L, the screw and small cock for adjusting the locking of the wheel.

Fig. 4 is a diagram to shew Mr. Watkins's intention of reducing friction, by bringing the action more concentric with the scape-wheel.

Description of a Compensation-Balance for Time-Keepers.

Invented by Mr. WILLIAM HARDY, *of New North-street, Red Lion-square.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

Thirty Guineas were voted to Mr. HARDY *for this Invention.*

THE honour done me, and the encouragement which I last session received from the Society of Arts, for my contrivance of a banking to a time-keeper, embolden me to trouble the Society with a new compensation-balance, which I conceive to be more perfect and permanent in performance than any hitherto presented to the public; and I have every reason to expect that it will be found

found of equal, if not greater, importance than my last contrivance.

Description of a new permanent Compensation-Balance for a Time-Keeper.

We have at present two compensation-balances: one sort consists of several slips of brass and steel soldered, or fluxed together, and disposed in form of two SS's on the balance, but this is now almost out of use. The other is a steel balance, having a rim of brass fluxed upon its outside, and cut open in two or three places, with sliding weights placed on the rim, to increase or diminish the effect of the balance. The nature of this balance (the only one now in use) is well known, as well as its defects, which it is unnecessary for me to state at this time, as I shall have a better opportunity of pointing them out at large, should I be ordered to attend the Society.

Instead of this uncertain way of constructing a balance, which never continues long in the same state, but requires to be adjusted every time the watch wants cleaning; I have rejected this mode altogether, and have contrived a method of applying the direct expansion of metals, which I find by experience to be constant and permanent in its effects.

My balance consists of a steel flat bar, which forms its diameter. Beneath this steel bar are two metallic rods, secured at one end by a stud, formed out of the steel bar, and the other end acting on the short end of a lever, formed out of the other end of the same steel bar, being made to spring at the place where the centre of the lever would fall; to this lever is fastened a small cylindrical stem of brass, upon which a small globe of brass slides or screws; there is also a screw passing through the stem, to serve to regulate to mean time. Another me-

tallic bar, equal and similar, and furnished like the other, but reversed in position, is placed parallel to it.

Mode of acting.

When the whole balance is heated, the metallic rods will push forward the short ends of the levers, and which quantity will be just equal to the difference of the expansion of the two metals. Suppose the short ends of the two levers to be each equal to 1, and the long ends of the levers to be each equal to 20, then it is evident that the motion of each globe will be twenty times the excess of the steel bar and metallic rods nearer to the centre of the axis of the balance than before the expansion took place; and, what is a very grand and necessary property in the motion of the two globes, they will always move directly to the axis of the balance; that is, their action will be constantly in a plane, passing through the axis of the globes and axis of the balance. To increase or diminish the expansion of the balance, will be only to slide or screw up or down the globes upon their stems, until the balance produces the desired effect.

The rim of brass and steel of the common balance, however intimately connected when first fluxed together, are by every change of temperature endeavouring to break the connection, and do by little and little tear themselves asunder, at least in a partial degree, for the fracture is often visible, so that the balance has nothing permanent in its nature. New adjustment is necessary much oftener than the instrument requires cleaning: but that adjustment is of no duration; for, as the pores are more torn than at first, the balance becomes worse and worse, and at last quite useless for what it is intended.

I make use of the direct expansion of metals; for the bars of my balance are independent of each other. They

are

are connected only at the extremities, and the excess or difference of the expansion of the two metals is communicated to the short ends of the two spring levers. Its durability can therefore no more be doubted than that of the gridiron pendulum, where the direct expansion of metals produces the desired effect.

The two globular weights were described in my last letter as moving constantly in the same plane, which passes through their centres and the axis of the balance; and I should have added that, as to sense, they also move in the same right line which passes through the centres of the globes, and cuts the axis of the balance at right angles; for the versed sine of a very small arch, or the difference between the radius and co-sine, is in this case a quantity so small that it cannot be perceived; and however we increase or diminish the expansion of the balance, or whatever may be the degree of temperature, it still retains this admirable property, namely, that the two spherical weights move not only in the same plane in a strict mathematical sense, but also in the same right line in a physical one. This quality, united with the direct motion of the brass bars, renders the motion of the globes simple and uniform, and therefore the effect (depending on such simple and direct causes) is regular and certain.

The common balance, when in motion, causes the weights to fly off or recede from the axis of the balance, and this flying off will increase and diminish with the arch of vibration in the balance: for, as there is nothing to brace the rim at the extremity of which the weight is suspended; as the arch of vibration increases, the weight and rim are thrown outward as much as the centrifugal force of the weight exceeds that of the elasticity of the rim. And as the arch of vibration diminishes, and consequently

sequently the centrifugal force, the weight is thrown inward by the elasticity of the rim.

My weights or spheres are firmly braced in every degree of temperature, and consequently not influenced in the smallest degree by any change in their centrifugal forces; therefore, in every respect, this balance may be considered as permanent.

The great difficulty in constructing a balance, and in applying the direct expansion of metals, is to contrive it so as that it shall preserve its equilibrium in every degree of temperature, and also admit of having all its parts made perfectly equal and similar by mechanical means. Both these important problems I have solved, by the introduction and application of a different principle from any yet used in the construction of the balance of a time-keeper; and I am fully satisfied, from a variety of experiments which I have made, that by this total change of system I have made a higher step towards the perfection of time-keepers than has been effected by any other means that have come within my knowledge.

The real respect which I have for the Society of Arts, will not suffer me to offer any thing that I do not consider of the first consequence; if I am right, I may justly claim the attention of the Society. I have not any other thing (in my own opinion) so worthy of their notice as this *permanent balance*, whose merits I submit to their judgment.

The following Letter is from Mr. NICHOLSON, *of Soho-square.*

I take the liberty to express my opinion of the compensation-balance, which Mr. Hardy has submitted to the consideration of the Society of Arts. I think it a very excellent contrivance: the following are some of the

the reasons which, I presume, will entitle it to the approbation of that respectable Institution.

First. The invention of confining the flexure of the steel bar to a small part near the end is new, and no less remarkable for its ingenuity and simplicity than for the steady effect it produces.

Second. The whole combination is particularly firm; and as the workmanship depends upon faces which are either plain or turned in the lathe, it can very easily be manufactured without requiring uncommon skill in the workman.

Third. As it has neither working surfaces of contact, nor joints nor levers, it will regularly obey the minute changes of temperature, and will not act by jerks or starts.

Fourth. In the expansion-bar, consisting of two metals, connected longitudinally by soldering or otherwise, the differences of length between them, when heated or cooled, are found to produce a bending of the whole bar, which is more the thinner its component parts. At the very surface of contact, and at a considerable distance on each side of that surface in thick bars, the principal effect must consist in what workmen would call wire-drawing the one metal, and upsetting the other. It is reasonable to think that this process must affect the properties of a balance so constructed, and cause it to deviate in the course of time from its original adjustment. This objection to the common expansion-balance appears to be obviated in Mr. Hardy's invention. The flexure of the brass takes place through its whole length, in a regular manner, and is in quantity but small; and the flexure in the reduced parts of the steel bar will be equally slight, if the thickness of that part be made to bear the same proportion to its length. Hence, and upon the whole, it may be concluded that when once it

is

is adjusted it will not alter, and that in all changes of temperature it will be similarly affected, and will return to its original figure whenever the first temperature is restored.

Fifth. Artists will probably consider it as a desirable property of the present instrument, that the adjustments for temperature being made in lines nearly parallel to the verge, will have no practical effect in deranging the adjustments for position.

A certificate, dated March 6, 1805, was received from Mr. Alexander Cumming, of Pentonville, stating that he had seen Mr. Hardy's expansion balance; that in his opinion it has considerable merit, and promises to act uniformly, steadily, and permanently.

REFERENCES to Plate XII. Figs. 5 and 6; expressing in inches and decimal parts of an inch, the dimensions of the several pieces.

Fig. 5, A A, two globes which slide on the cylindrical stems of two upright levers, and are fastened by screws, by which the effect of the expansion is increased or diminished. C C, two equal and similar screws, by which the watch is adjusted to mean time. D D, the verge or axis of the balance. E E, the combination of the steel bar with the brass bars.

Fig. 6, S S, the steel bar, whose length is - -	1.600
Its breadth - - - - - - - - - - - -	0.232
Its thickness - - - - - - - - - - -	0.032
B B, two similar and equal brass bars, in length each	1.470
In breadth each - - - - - - - - - -	0.078
In thickness each - - - - - - - - -	0.032
Length of the two springs formed out of the steel bar - - - - - - - - - - -	0.030

Facts

Fig. 1.

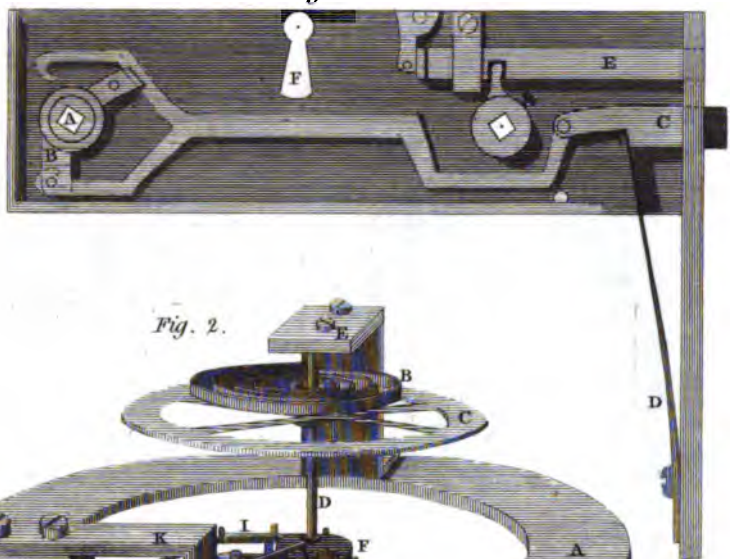


Fig. 2.

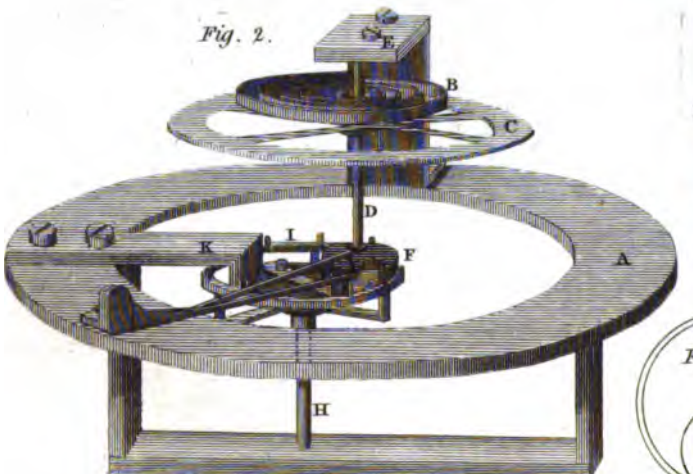


Fig. 4.

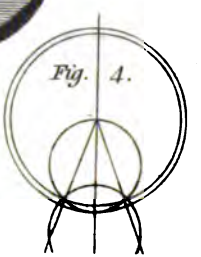


Fig. 6.

Fig. 5.

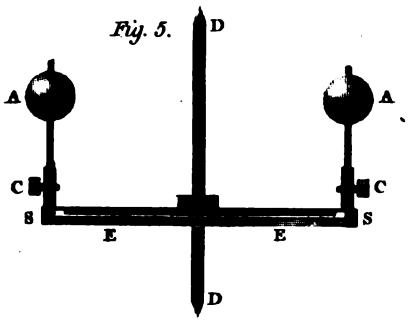
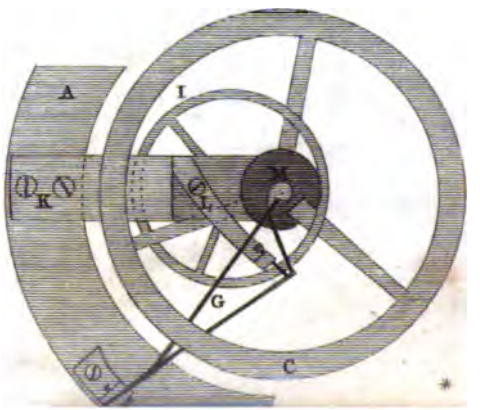


Fig. 3.



Facts relating to the Chemical History of Gold.

By Professor PROUST.

From the JOURNAL DE PHYSIQUE.

TO ascertain the quantity of oxygene which gold takes to dissolve in the acids, is a point of importance to be determined in the history of this metal, and which I have found to be attended with more difficulty than I had imagined.

Six hundred grains of muriatic acid at 12° of Baumé's areometer, and 200 of nitric acid at 40, dissolved with the aid of heat 144 grains of gold. Having added 200 grains of muriatic acid to this solution, it took 43 grains of gold; that is to say, 16 drachms 48 grains of aqua regia made with four parts of muriatic acid and one of nitric, of the strength indicated by the above-mentioned weights, can dissolve 2 drachms 43 grains of this metal. The nitric acid serving here only for the oxydation of the muriatic, it is evident that the latter, which is the true solvent of the gold, ought to predominate in the aqua regia. The same circumstances take place in the solution of platina.

In order easily to obtain the muriate crystallized, it is proper to keep gold in excess in the solution, and to add successive portions of muriatic acid till it is perceived that no more action takes place. By this means we exhaust the nitric acid, and at last there remains no more of it that could impede the crystallization.

The solution, evaporated to a certain degree, gives a lamellated crystallization, which is even congealed if the concentration has been carried too far. This muriate is so liquefiable, so difficult to be obtained dry, and with-

out consequently being exposed to considerable loss, that it ought not to be taken out of the retort, if we have no other object in view than to exhibit it. In summer it becomes liquid in the morning, crystallizes towards evening, and passes through these alternations as long as the hot season continues.

The taste of the pure muriatic is harsh, combined with a degree of bitterness, but without that metallic flavour remaining in the mouth which renders the solutions of silver, of copper, &c. so disagreeable.

Spirit of wine perfectly dissolves the muriate of gold. This solution, aided by heat, experiences no alteration; the alcohol is not converted into ether; distillation separates them, and the muriate is recovered without having undergone any change.

This muriate distilled yields water and oxygenated marine acid in great abundance. The gold remains of a dull aspect and spongy texture at the bottom of the retort. The vapours carry with them some muriate of gold, which is found again in the receiver, but in very small quantity, as has been remarked by Boyle. The decomposition of the muriate of gold is perfectly similar to that of the muriate of platina; both give oxygenated acid and pure metal.

Auriferous Ether.

Sulphuric ether separates the muriate from the solution of gold, and leaves the nitric acid alone. The crystallized muriate also dissolves in it with the greatest facility, and without leaving a residuum.

The auriferous ether exposed to the air loses the solvent, and is reduced to a yellow acerb liquor, which is always pure muriate. Charles Hofman was, I think, the first who described this action of ether upon the solutions

lutions of gold, in his "Dissertation on the vinous vitriolic Acid." Baumé also appears to me to have been the first who proposed the auriferous ether for gilding watch-makers' work. Some years since it has been recommended as very proper for drawing designs in gold upon iron and steel. I shall give an account, not of successes, but of very fruitless attempts, which, it is to be hoped, will induce the author of this proposal to explain himself more clearly, if he wishes to be of utility to the arts, and to the numerous amateurs who complain of having lost their gold and their pains.

The ether which has become coloured upon the most highly-charged solution, is far from containing as much gold as would be requisite for gilding with success. With the aid of a syphon we draw off the discoloured liquor which is under the ether, and replace it by new solution; by this means the ether becomes darker in colour, and more and more charged. But when this has been repeated three or four times, the state of things is altered; the auriferous ether no longer swims at the top, but sinks to the bottom of the flask of the weight and consistence of oil of cinnamon, while the nitric acid floats at the top, and must be drawn off by the syphon.

Having at length surcharged the ether well with gold, and considering my success as certain, I began to trace letters upon polished steel, both with a pen and a brush. The marks turned out gold, as might have been expected, from its muriate applied to a metal which decomposes it so easily. But though I employed every means that I could devise, these marks never appeared with that quantity of gold, or that continuity, consistence, and lustre, which I wished them to exhibit. It is far from being a gilding equal to that of Solingen. We shall be no longer surprised at this result if we analyze

the effects of this gilding; for we soon discover that a single stroke of this ether applied to the steel, immediately produces four results, of which three at least are contrary to the end which we have in view. The deposition of the gold, the deposition of the muriate of iron, the exposure of the charcoal of the steel, and the depriving every point which it touches of its polish—these are the effects which we obtain.

Thinking to diminish the inconveniences arising from the muriate of iron, I immersed the plates in water as soon as the figure had been drawn upon them, and afterwards let them dry; but this did not give the figures either more adhesion or more lustre. The palm of the hand gently applied to them, in order to give it to them, immediately carried them away.

It was also to no purpose that I dried, by a degree of heat capable of burning one's hand, my plates after being gilded and washed. The gold did, indeed, acquire somewhat more adhesion; but friction did not increase its brilliancy, because, however highly charged the ether may be, it never deposits a sufficient quantity of metal in the stroke to cover its blackness, and for there to result that continuity of parts, that consistence, and that reflection of the light upon which the lustre of gold depends. Finally, this gilding, such as I see it at present, after the lapse of a year, upon the plates on which I made my experiments, has not even the merit of that which might be given with a solution of sulphate of copper. If such are the results obtained with an ether surcharged with gold, and from which I had reason to expect some success, what can be hoped from an auriferous ether prepared according to the common receipts?

Different

Different Precipitations of Gold.

Gold precipitated by sulphurated hydrogene, when washed and dried, is only a mixture of sulphur and pure gold. To heat it in a retort is sufficient to separate the metal from the combustible. Thus there exists neither a sulphuret nor a hydro-sulphuret of gold.

The sulphurous acid precipitates it pure. The gold is brought to a state of division, which I at first thought might be advantageously applied to the purposes of painting in enamel, or gilding; but the metallic particles soon exert an attraction which attaches and solders them together, causing them to assume the consistence of a spongy and tenacious body. In this state nothing more can be done with them.

Of the Precipitation of Gold by the Sulphate of Iron.

We succeed much better with the solution of this salt; there results from it a fine powder, of a purple-red colour, the hue of which has however no analogy with that of the purple of Cassius. It is washed with acidulated water, to clear it of iron, because in this state it is adapted for experiments which require an easy and speedy solution of this metal.

Marine acid of 12 degrees, boiled upon this powder of gold, sensibly dissolves a portion of it, and assumes a yellow colour; a plate of tin immediately occasions a production of the purple in it. Gold, aided by the affinities which favour iron, zinc, &c, can therefore decompose water. Thus the marine acid can also, contrary to the received opinions, attack gold and silver as it attacks so many other metals.

Nitric acid of 40 degrees, boiled upon this gold, also dissolves some of it, and becomes coloured.

An

An acid of 36 degrees likewise dissolves a portion of it, but so small a one that it is with difficulty we can discover it by means of tin. With an acid of 32 degrees, such as is used in the parting operation, it is doubtful whether any gold can be taken up, and the more so as the cornet is far from presenting so many points to its action as the powder of which we have been speaking.

Hydro-phosphorated water precipitates the solution of gold; that which covers phosphorus is in this state, but the effect belongs exclusively to the gas, for the phosphorous acid has no action upon this solution till after ten or twelve hours.

Precipitation by the Alkalies.

Potash purified by alcohol precipitates from the muriate of gold a powder which is yellow; afterwards violet, if we operate with a large quantity of water, but which appears black when it has been washed and dried. Nothing is so capricious as this preparation. Excess of alkali, saturation, heat raised to the boiling temperature, are insufficient to render us masters of it. The liquors always remain more or less charged with gold.

Frequently it happens, that from one day to the next the precipitation is completed; but instead of adding to the black powder, it covers it with a metallic pellicle, or even it gilds the vessel in the most brilliant manner. I have one in this state, which I keep as a curiosity.

Supposing the black powder to have been washed and dried; what one should have imagined must have been a pure oxyd is then only a mixture of oxyd and of reduced gold. This is what prevents our being able by this means to fix the degree of oxydation of this precious metal.

Muriatic

Muriatic acid applied, dissolves the oxyd, and leaves the gold pure, which is always the most abundant. Nitric acid of 40 degrees dissolves only some minute particles of gold: its effect must be aided by heat. This solution is slightly yellow: if we dilute it with water, the gold is separated from it of the colour of fulminating gold. This precipitate always retains the state of oxyd, and accordingly it is immediately dissolved by the muriatic acid.

Dilute sulphuric acid also dissolves some of it, but less than the preceding: this is perceived by the violet colour which it assumes, if we mix with it some drops of muriate of tin. Finally, the carbonates are not more effectual for the precipitation of gold, which obliged me to relinquish this labour, repeating with Bergman, *Omne aurum ægrè decidit, ideoquè pondera mihi sunt incerta.*

Fulminating Gold.

A hundred parts of fulminating gold, passed through sulphurated hydrogene, washed and heated, left 73 of pure gold. If we could find the means of appreciating the ammoniac which attaches itself to the oxyd, we might easily deduce thence the oxydation of the gold. A hundred parts of gold consequently give very nearly 137 of fulminating gold.

Kunkel discovered that the oxyd of gold obtained by the alkalies, and moistened with ammoniac, became fulminating. Orschal is also to be mentioned as one of those who narrowly escaped falling victims to its detonation. An agate mortar, in which he was pulverizing this dangerous oxyd, flew under his hands into innumerable pieces. He was not indeed wounded by it, but he says that he experienced the same sensation as if a gun loaded with sand had been discharged into his face. According

to

to him Raymond Lullius was likewise exposed to the same danger.

Orschal likewise employed fulminating gold for giving a purple hue to glass. It even appears that this application was known before him. Accordingly it might be concluded, from that time, that tin was not an ingredient necessary for the purple colour.

Fulminating gold, wetted with muriate of tin, is changed into purple of Cassius, because it thus loses the oxygene; but the purple thrown into ammoniac gives very different results, of which we shall speak hereafter.

Gold and Mercury.

If solution of gold be dropped into that of nitrate of mercury at the *minimum*, a violet powder is deposited, which, according to Orschal, gives a very beautiful purple. This purple is a mixture of metallic gold and sweet muriate: to separate the one from the other, nothing more is requisite than to heat it in a retort. But if, on the contrary, we pour the solution of mercury into that of gold, in such a manner that the latter predominates, the precipitate is found, after twelve hours, to be pure gold. This arises from the circumstance, that the sweet mercury is, in its turn, decomposed. Sweet mercury, kept in a purely muriatic solution of gold, precipitates this metal, disappears, and is found converted into corrosive sublimate.

The nitrate of mercury, of which the oxyd is completely at the maximum, also precipitates the muriate of gold, but the results are very different, and deserve to be known.

In order to understand all that passes in this precipitation, it must be recollected,

1. That

1. That the oxyd of mercury being more attracted by the muriatic acid than by the nitric, it always tends to abandon the latter in order to unite with the former.

2. That the oxyd of mercury having more affinity with the muriatic acid than that of gold, the first must infallibly displace the second with this acid.

3. That the mercury being once saturated with oxygene, will precipitate the gold, provided with all its oxygene, that is to say, such as it exists in its solution, because there is then no cause why it should take it from it.

4. That if the oxyd of gold is separated from the muriatic acid by that of mercury, it will be deposited on account of its not being soluble in the nitric acid, which that of mercury has abandoned. These four effects actually take place in the precipitation of which we are about to treat.

We therefore begin with preparing a solution of mercury, by dissolving red oxyd in nitric acid; we dilute it with eight or ten times its volume of pure water, and then pour solution of gold to it at several times. There is then produced a yellow precipitate, much resembling fulminating gold in colour. We let it deposit, draw off the liquid, wash the precipitate several times with boiling water, and at last dry it in a capsule.

If we continue to exhaust the mercurial solution, by repeated additions of that of gold, a period arrives when the latter no longer renders it turbid; of which the reason is evident. The nitrate of mercury has at last been totally changed into corrosive sublimate. Now the sublimate whose oxyd is saturated with oxygene cannot decompose the muriate of gold.

If the nitrate of mercury used for this experiment were not completely at the maximum, it is evident that we

should run the hazard of having sweet mercury produced, which would then unite with the oxyd of gold.

This precipitate is not, as I had at first hoped, a pure oxyd. It remains mixed or combined with a portion of corrosive sublimate, from which repeated washings cannot free it.

A hundred parts of this dry precipitate, heated in a retort, gave water, oxygene gas, sublimate and gold, in the following proportions:

Water - - - - - - - - - - - -	8
Sublimate mixed with sweet mercury	16
Gold - - - - - - - - - - - -	70
In all - - - - - -	94

The oxygene fixed to the gold was therefore 0.6. Accordingly gold would take for its oxydation 8.57 to the quintal. But as these results did not yet satisfy me, I thought it necessary to commence a new precipitation. The precipitate came with the same appearances; it was washed a much greater length of time than the first. However, the last washings were still rendered a little turbid by the test of the minor muriate of tin; but the products of its distillation, though the same, presented themselves in a very different manner.

I placed 100 grains in a small glass retort over the flame of a lamp. Scarcely had a few minutes elapsed, when a rapid explosion of white vapours took place, forming a dense cloud, which I took care not to respire. I judged that a precipitate disoxydation of the gold had produced this kind of detonation, and, in fact, the gold was found completely disoxydated. The retort was lined with sweet mercury mixed with sublimate.

I repeated

I repeated this distillation, throwing precipitate, by small portions, into a matrass of a determined weight placed over the lamp. The results, which were less tumultuous than before, permitted me to observe them better; but it was impossible for one to appreciate the quantity of the moisture, and consequently to determine the proportion of the oxygene to the gold.

However, the oxygene abounds much more in this precipitate at the exterior surface than internally, for 100 grains of the latter having given

Sweet and corrosive muriate - -	16
Gold - - - - - - - - - -	58
	74

it is evident that the 26 which are wanting to complete the quintal, not being able to contain more than about 8 parts of water, the oxygene must be about 12 to 58 parts of gold, which would give for the proportion of metal 100, oxygene 31. At all events I am much inclined to consider this proportion as much more certain than that of the preceding experiment; because, having applied ebullition to the first of these precipitates, a portion of the gold might be more or less disoxydated; a circumstance which I took care to avoid in the preparation of the second. But it would undoubtedly be premature to attempt to establish a theory upon these facts. For this purpose it would be necessary to see them over and over again, which I am debarred from doing at present by my other avocations. I shall only observe that the sweet mercury which here accompanies the oxyd of gold did not proceed from any portion of oxyd at the minimum, which my mercurial solutions might have retained. What then is the origin of this sweet mercury?

What can be the concurrence of affinities which have reduced the sublimate to the state of sweet mercury, and thus attached it to the oxyd of gold.

I shall terminate these details with a much more extraordinary property of this precipitate than those of which an account has just been given.

If we heat some grains of it upon a piece of paper over the flame of a paper, it soon melts and flies, puffing out its white vapours before being reduced to the state of gold. But if we previously mix it with a small quantity of flowers of sulphur, triturating them together with an ivory spatula, and afterwards heat it gently over the candle, it detonates very readily, and with as clear a sound as fulminating gold.

The first of my two precipitates, in which I had suspected less oxygene to exist than in the second, detonates, however, as well as the second.

The oxyd of gold obtained by potash, mixed with sulphur, and heated in the same manner, fuses obscurely, but without having the slightest tendency to detonation. The detonation of the preceding oxyds is a constant property which never fails. After the detonation, nothing is found between the pieces of paper but gold in a divided state.

To reflect now upon so singular a result, we here see gold fulminate by a means which destroys this property in the ammoniacal fulminating gold, and we bring it, without the concurrence of ammoniac, to produce effects, the concurrence of which must necessarily render even the theory of the fulminating gold very doubtful. What can be the influence of the two muriates of mercury in this detonation? This is what still remains to be investigated.

Purple

Purple of Cassius.

It is at present well known that the gold is reduced in this purple to the metallic state, since the experiments of Pelletier have demonstrated that the tin, or its oxyd at the minimum, applied to the muriate of gold, could never give any other result. But as it is also known that it contains a portion of oxyd, and that a considerable one, it has been generally thought that the purple must, on that very account, be only an intimate mixture of gold in the metallic state, and of oxyd of tin.

If we, however, reflect upon some properties which eminently distinguish the purple from a simple mixture of gold-powder and of oxyd, and especially upon the difficulty which we find in separating the latter from it, we are led to suspect that there must be something more in this precipitate than a simple mixture.

Let us, therefore, first establish the metallic state of the gold: after which we shall ascertain the degree of oxydation of the tin which accompanies it.

In order to analyze the purple, it is necessary to apply aqua regia to it; for the nitric and the muriatic acids have but a very slow and imperfect action upon it. Almost as soon as it has been poured upon it we see it lose its colour, give a solution of gold, and leave the oxyd of tin free. This oxyd is heavy, sandy and transparent, like pounded glass; which are the usual characteristics of the oxyd at the maximum. But it may be objected, the nitric acid of the solution might have raised it to this degree. No, I answer; for if we heat the purple in marine acid, the oxyd we separate from it is equally vitreous, and its solution no longer precipitates that of gold; it only gives yellow with hydro-sulphurated water. It cannot therefore be doubted, that if the tin which accompanies the

the gold is at the maximum, it is because it has seized upon its oxygene in proportion as it has precipitated it. Oxyd of tin at the maximum and gold are therefore undoubtedly the constituent parts of the purple of Cassius.

In order now to shew that this oxyd cannot, during the precipitation of the purple, unite with the gold, except in as far as a particular affinity attracts it to this metal, we shall here notice some of the properties of the oxyd of tin.

Tin passing from the minimum to the maximum of oxydation, diminishes in solubility. This is a fact which has been sufficiently demonstrated in my last memoir upon tin. In this respect it follows the same law as most of the metals that are susceptible of two states of oxydation. But this diminution of solubility is not, however, the cause of its precipitation in the present circumstance; for, though less soluble than the minor oxyd, it is nevertheless considerably so both in the muriatic acid and in aqua regia. If we pour, for example, a single drop of muriatic acid at the minimum, which is very acid, into a solution of gold, which is habitually surcharged with it, we shall not fail to produce a purple compound, and a purple which assuredly is not to be compared to the coloured powders produced by the sulphurous acid, the phosphoric acid, the sulphate of iron, &c. Accordingly, in the case which we are examining, there is no reason to believe that some atoms of oxyd, which have been raised to the maximum, thus abandon a solvent, which acts on them every where, to unite in preference with the gold, unless the latter attracts them by the force of a particular affinity. It is also to be observed, that in proportion as the gold and the tin are precipitated, the acidity of the liquors is augmented.

Thus

Thus if the gold and the oxyd unite, notwithstanding the obstacles which they must meet with in the midst of such acid menstrua, some particular attraction must necessarily intervene to prevent the tin from obeying its accustomed solubility.

But a single fact will give the fullest evidence of the particular state of combination which attaches the oxyd of tin to the gold. If we throw tin, recently precipitated, into a flask of ammoniac, the latter is immediately dissolved, and becomes tinged with a lively and intense purple colour. The solution passes through the filtre without losing any thing. Water does not decompose it, like most of the ammoniacal metallic solutions, at least not unless it be surcharged; then a part of the purple may be separated from it. Distillation, by carrying off the ammoniac, also causes it to deposit; but if the liquor retains ammoniac, it still contains some purple in solution. The acids precipitate it in like manner.

The metallic precipitates of gold are not soluble in ammoniac. The oxyd at the minimum is but very imperfectly so, since its solution is always milky. If the purple dissolves as amply and as well in ammoniac, if the purple has properties which neither the gold nor the oxyd possesses, it must therefore be concluded that these two substances form a real combination with each other. Now, it is only the real combinations that can have properties eminently different from those which characterize their factors. The combination of a metal, the affinities of which are already so limited, with an oxyd which its extreme oxydation reduces to an equally low rank in its own, cannot but appear singular, and the more so, as there does not, I believe, exist any other which can be compared to it. To this it may be answered, that that of the oxyd of gold with ammoniac will not perhaps appear less

lets out of rule if more nearly examined; for what is more in opposition to the generality of principles, than to see an oxyd having more affinity with ammoniac than the strongest acids; than to see in fulminating gold an oxydo-ammoniacal combination, which no acid, and even no alkali, can overcome?

Mercury shaken in a bottle with fresh purple does not separate the gold from it, as it does so advantageously in all mixtures where there is no combination. If the really metallic gold in the purple does not, however, yield to the action of the mercury, it must be opposed by some other affinity.

It has also been thought that no essential difference existed between the gold precipitated by tin and the gold precipitated by the sulphate of iron, and even that the latter required only to be extended or diluted in any white oxyd, in order to be purple of Cassius. I must say that these ideas have very little foundation; for, if the gold precipitated by the iron has any thing of a purple hue when it is deposited, it has this cast only under one aspect exclusively; whereas that of Cassius is a constant purple in whatever position it be viewed.

All gold which is reduced to the metallic state by other combustible substances than by tin, gives a precipitate of which every atom refracts the light in such a manner as to appear blue when the vessel is placed between the light and the eye. It is this appearance which gold exhibits when precipitated by the sulphate of iron, by phosphorated hydrogene, by sulphurous acid, &c. If we place our eye between the light and the vessel, we still perceive no purple colour; but we distinguish that reflection which is peculiar to every auriferous molecule, and in which we so easily distinguish atoms of metal. But the gold precipitated by tin is, on the contrary, of a deep

deep crimson colour, it is purple, it is a velvet-like colour, which exhibits no metallic reflection under whatever angle we view it, and the tint of which differs from that exhibited by its solution in ammoniac only by its greater intensity.

If we wish to convince ourselves still more fully of the real difference which exists between the auriferous precipitates and the purple of Cassius, it will be sufficient to call to mind, that though the muriate of iron acts upon the muriate of gold in the same manner as that of tin, the oxyd of iron which causes its precipitation is nevertheless by no means attracted by the gold like that of tin, notwithstanding that its solubility has in this circumstance undergone full as great a diminution as that of the oxyd of tin. If, therefore, the oxyd of iron raised to its maximum does not attach itself to the gold in a situation in which that of tin never fails to do it, it is certainly nothing but the affinities that can account for these differences.

And, finally, the purple of tin attaches itself to silk, and dyes it violet, which is assuredly not the effect of a gold powder incorporated in the pores of its filaments.

In the formation of the purple the excess of the acids have a very different use from that which might be attributed to them; they do not separate oxyd of tin from it as might be imagined, but they occasion, they communicate to the purple, a kind of semi-solution, which retards its deposition, and which thereby produces much inconvenience, especially when it is an object to collect it speedily. This action of the acids may be easily perceived, if we agitate a fresh-washed precipitate with marine acid: one might then be induced to assert that a dis-

solution took place, and the more so if we heated it a little; but this solution, which imposes upon the eye a kind of transparency, does not stand the test of the filtre.

The precipitation of the purple is accelerated by adding potash to the liquor at several times. If at the end of some minutes the liquor does not clear, we add a little more, and we have the satisfaction of seeing the purple collect in flakes and deposit itself. In this precipitation, however, an excess is to be dreaded; but it is easily avoided when we are aware of its bad consequence; which is, that any quantity of potash, more than what is required for neutralizing this surplus of acid, would in its turn attack the free muriate of tin which the liquors hold in solution, and we should run the hazard of adding to the purple a portion of oxyd, which ought not to form part of it.

TO BE CONCLUDED IN OUR NEXT.

Discovery

Discovery of a new Vegetable Principle in Asparagus. (Asparagus sativus, LINN.)

By Messrs. VAUQUELIN *and* ROBIQUET.

From the ANNALES DE CHIMIE.

BY examining more attentively than had formerly been done the products of vegetation, modern chemists have discovered a great number of species of them, which were unknown to the Ancients; but it is long since there has been found in vegetables an immediate principle so singular and so interesting as that of which we are about to speak.

During the last summer M. Robiquet, a young chemist, who with solidity of reasoning unites great ability in making experiments, subjected, at the recommendation of M. Parmentier, the juice of asparagus to chemical analysis, the interesting results of which he has recorded in the Annales de Chimie.

Having left in my laboratory (during a journey which he made) a certain quantity of the juice of asparagus, concentrated by evaporation, I observed in it a considerable number of crystals, of which two appeared to me to belong to new substances. As they differed in form, transparency, and taste, it was easy for me to separate them.

One of these species, which was perfectly white and transparent, after having been several times crystallized, has a cool taste, somewhat nauseous, which excites a flow of saliva; it is hard, brittle, and has a regular form.

The other species, which is equally white, is neither so transparent nor so hard as the other, nor does it crystallize in the same form; it is, on the contrary, without

consistence, crystallized in fine needles, and has a sensibly saccharine taste analogous to that of manna.

M. Robiquet, in making the experiments which we have mentioned, had observed the first of these substances, but he conceived it to be an ammoniacal salt, because having then been able to procure it only in very small quantity and imperfectly purified, it retained, to all appearance, among its laminæ, some traces of salt with an ammoniacal base, with which the juice of asparagus abounds; and this deceived him.

From that time we jointly subjected this substance to new experiments, the principal of which follow. The form which it affects in its crystallization, according to M. Haüy, to whom we sent a certain quantity of it, derives from a right rhomboidal prism, of which the large angle of the base is about 130 degrees. The sides of this base, and the two angles situated at the extremity of its great diagonal, are replaced by facettes.

This substance is moderately soluble in water, and its solution exhibits no marks either of acidity or of alkalinity. Neither the infusion of galls, the acetate of lead, the oxalate of ammoniac, the muriate of barytes, nor the hydro-sulphuret of potash, produce any change in the solution of this substance. It is not soluble in alcohol.

These experiments shew that the substance in question is not a salt with an earthy base. We triturated a certain quantity of it with caustic potash and a little water, in order to see whether ammoniac would be disengaged from it, but no sensible traces of it were perceived: the potash seemed to us to render it more soluble in water.

Seeing then that it contained neither earth nor ammoniac, we examined whether any of the alkalies existed in it; for which purpose we burnt a considerable quantity

of

of it in a crucible of platina. It immediately puffed up considerably, exhaling pungent vapours, which affect the eyes and nostrils like the smoke of wood. It yields much coal, which has no taste, and which, after incineration, leaves only a scarcely perceptible trace of earth, which certainly is extraneous to it.

At the end of the decomposition of this matter the odour exhaled from it is a little analogous to that of the animal matters, and also slightly ammoniacal.

Nitric acid decomposes this substance; nitrous gas is disengaged, the liquor assumes a yellow colour, a bitter taste like the animal substances; when the action of the nitric acid is completed, lime disengages ammoniac in abundance from the liquor.

This alkali is therefore formed in the operation just described, since the substance of the asparagus presented no sensible traces of it before.

This substance is not an acid, since it does not redden the turnsole tincture, and is devoid of that taste which all these bodies possess in a more or less marked degree.

It is not a neutral salt, since it contains neither earth nor alkali; but as it yields, with the aid of fire, the same products as vegetables, we are obliged to consider it as an immediate principle of the asparagus.

It is probable that it is composed, like them, of hydrogene, oxygene and carbone, in particular proportions; and it is no less probable that there exists in it also a small quantity of azote; at least this seems to be indicated by the odour which heat disengages from it, and the ammoniac which it forms with the nitric acid.

Although we obtained a considerable quantity of this substance, we have not been able to subject it to more experiments, because the greater part of it has been lost in our laboratory, and we have none left but the small quantity

quantity which we sent to M. Haüy for him to ascertain its form. Nevertheless, we thought it incumbent upon us to communicate our discovery to the Institute, in order to fix its date, intending to pursue our researches as soon as the asparagus season shall arrive.

We shall also examine whether this singular substance exists also in other vegetables.

As to the saccharine matter which we also found in the asparagus juice, we had not a sufficient quantity of it to determine to what species of sugar it bears the greatest resemblance; we think, however, that it is to manna.

It may therefore be considered as certain, that besides the principles discovered in the juice of asparagus by M. Robiquet, there exists in it a principle which is crystallizable like the salts, and which yet is neither acid nor neutral salt, and the solution of which in water is not affected by any of the re-agents which are ordinarily employed to ascertain the presence and the nature of salts dissolved in water; and another saccharine principle, which appears to be analogous to manna.

Facts relating to the Chemical History of Silver.

By Professor PROUST.

From the JOURNAL DE PHYSIQUE.

THE muriate of silver is soluble in muriatic acid, and it separates in octraedal crystals. This solution is decomposed by the addition of water, and the muriate is precipitated.

This acid poured upon refined silver attacks it, and transforms it into muriate; a gas escapes which forces out the stopper; this can only be hydrogen. The acid which

which is weakened retains scarcely any thing in solution, for it is hardly coloured with hydro-sulphuretted water.

That Bergman should have considered this muriate as composed of 75 silver and 25 acid, was natural; but when the Moderns repeat this assertion, they certainly do not recollect the oxygene which necessarily enters into the composition.

Muriate of silver does not pierce the crucibles, neither does it attack them, or even penetrate the surface.

Muriate of silver has not appeared to me to be volatile. During the first impression of heat, and by the help of moisture alone, a vapour escapes, which condenses in the space of a crucible inverted upon that which contains the muriate. This is a sublimate which has, as Stahl has observed, the appearance of flowers of arsenic; but when the muriate is melted, it exhales no more of these vapours, but remains fixed to the bottom of the crucibles. Four drachms of melted muriate have been kept of a cherry-red, for half an hour, in a covered Hessian crucible. The crucible at the end of this experiment had lost six grains; but this was only because a little of the muriate had made its way out by one of those defects of continuity so often found in the clay when it has not been carefully worked before it is baked.

Half an ounce of the same muriate, heated also for a long time in a luted retort, neither attacked the retort, nor exhibited the slightest appearance of sublimation. M. Sage has seen it in the same light.

The muriate heated to this degree is transparent, and has a tinge of pearl-grey colour, which always distinguishes it. Under this aspect it so perfectly resembles the native muriates, that it is impossible not to confound them with it, their proportions being the same; so true

it

it is, that nature has not two modes for combinations of this kind.

The muriate has a strong tendency to crystallize in octaedrons. I have a mass which weighs four ounces; in the thickness of which is formed a horizontal cavity, which is covered with them. The solution of the muriate in ammonia likewise yields regular octaedrons.

The ammoniacal solution may be preserved for years without the muriate tending to decomposition; but, if it is attempted to effect a separation by even a moderate heat, fulminating oxyd will be formed. The following fact apprised me of this circumstance: I placed in a mild heat a capsule with some ammoniacal solution, intending to collect the muriate. The liquor evaporated to a certain degree, and some grains of deposit being already formed, I raised it by the edge, and imprudently put it into my other hand; the powder at the bottom soon detonated; it burst the bottom of the capsule, and the explosion dashed all the liquor into my face, and blacked it so much, that it remained in that state for several days.

To give a clear idea of the characters of this muriate (and even to give instructions how to know it), it must be poured, of a half-red heat, into a silver basin, and stirred circularly like melted nitre. It then comes out in a thin plate, transparent, and flexible, which may be cut with scissars, almost as easily as lantern-horn.

If it be left to cool in the crucible, that it may be taken out in thicker masses, it will, as Kunckel has remarked, bear turning in a lathe; he says it succeeded much better in masses of eight ounces than in one ounce. I have some plates which have a red cast, and are sprinkled with scales; but the light darkens them, and consequently diminishes their value for trinkets.

Kunckel,

Kunckel, in his chemical laboratory, has furnished a method of reducing the muriate, which is expeditious, and not exposed to great waste. He says, treat three parts of grained lead with one of muriate of silver in a retort, the lead will change into muriate, and will swim upon the silver, which will be found reduced. The produce, however, is not reduced silver; it must be cupelled again, to deprive it of a good portion of lead. But this process may be improved; for three parts of lead are a great deal too much. Enclose the muriate, which I suppose to be melted, in a leaf of lead double its weight (lead reduced from salt of lead); cupel it, and it will produce sometimes $\frac{73}{100}$, sometimes ,74 and a fraction. In the course of four operations I could not obtain ,75 and fractions, which is the real product. It loses, therefore, a little silver, and I do not know whether the muriate of lead which volatilizes does not contribute thereto.

It has been recommended to reduce the muriate by carbonate of potash. This method is embarassing, for it exposes it to considerable loss on account of the swelling, the extravasation, and the large-sized crucible, which must be used to avoid these inconveniences, even with small quantities of muriate.

Caustic potash is preferable, since it effects the reduction without swelling; but for large quantities of muriate this method becomes dear.

Having had about a pound of muriate, the result of repeated precipitations which had been made in a laboratory, I preferred the following method, of which M. Sage is the author.

It consists in boiling the muriate in an iron stove with some small pieces of iron and some water; the separation is quickly effected. The liquor, which is muriate of iron, is to be poured off; the water to be renewed; it is to be

shaken now and then, and a silver powder will be obtained, which need only be washed, and melted with a little saltpetre and borax, in order to purify it from some remains of the oxyd of iron. To be assured of the entire decomposition of the muriate, it is sufficient to expose the silver powder to the sun; and if it contains any muriate the light will give it a dark violet colour.

To enable me to judge of the value of this method, I made the following experiment.

I treated, in a small silver basin, a hundred parts of muriate in powder, very dry, with as much filings of iron, and a sufficient quantity of water. The operation being finished, the muriate of iron emptied out, and the powders washed, I added eighteen parts of mercury to collect the silver. The amalgam when distilled gave ,72½, it ought to render ,75¼. By applying more mercury to the filings, I obtained ,2½ of silver: total ,75. The loss therefore was only ,00¼, or four grains, because the experiment was made upon 1600 grains of the muriate.

This result shews, that for moderate quantities of muriate, the reductions may be made without trouble or perceptible loss. In a large way it is still more expeditious, since it is only required to place the muriate upon the lead in the cupel.

The silver which is separated from the muriate by potash, though well melted, is not always entirely free from remains of the muriate. Being one day employed in forging a mass of about eight ounces, I was surprised to see it become leafy under the hammer. On examination I discovered some muriate not reduced between the leaves. M. Fernandez has likewise made this observation: it will be found at the end of this article.

The

The muriate of silver is frequently met with in the minerals of America; it accompanies native silver, is disseminated in sulphurets, in carbonates, and in siliceous rocks, till it becomes imperceptible. I examined an ore of the province of Caracas, which by the application of acids produced only eleven marks to the quintal; but when melted with oxyd of lead, potash, and charcoal, it yielded a regulus, which left nineteen marks upon the cupel. This mineral contains both metal and muriate. The silver of this ore contained at most a thirty-sixth part of gold; its matrix was siliceous.

To discover the muriate, the mineral in powder was boiled in water with a few filings of iron or zinc; the muriate became decomposed, was washed, and by applying nitric acid the silver was discovered. As to the muriatic washings, it was precipitated with solution of silver, and a portion of muriate was collected, which exactly represented that which existed in the ore.

Sometimes there comes from Peru pieces of native muriate of the greatest purity. I have a specimen of about ten ounces, which has for its matrix rhomboidal carbonate. This muriate is transparent, pearly, and sectile without harshness. Its cuttings, when exposed to the sun, take the violet tint in a few instants; it melts in a retort without losing any of its characters, and without being diminished in weight. If brought near to the flame of a taper it runs in red drops, like the juice of gooseberries, which whiten as they cool. They should be dropped upon a plate of glass. The artificial muriate also melted in coloured drops. The native muriate, wrapped in a leaf of lead, only gave rather more than ,74, though it contained about ,75¼.

I decomposed 100 parts of this muriate by zinc, and precipitated the washings with nitrate of silver. The

produce collected was 100 parts. I have obtained this result twice. The solution of silver which remains mixed with the zinc after the decomposition, may be employed likewise for this purpose; but the necessity of filtering it occasions a slight loss, for only from 98 to 99 is obtained. The muriate which is reproduced must not be weighed till it is perfectly dry.

The native muriate is also found mixed with carbonate of silver in powder, forming a grey ore, quite uniform; it is very difficultly frangible; rubbing it with a hard body discovers the silver by its shining. I have a piece which is composed of 30 of silver, of calcareous carbonate 32, of muriate 38.

As far as I can judge from appearances, it is this ore that envelopes the famous piece of native silver which is preserved in the King's cabinet. This piece, of nearly three hundred pounds in weight, is still charged with a part of its precious coat, and would have been much higher in the estimation of mineralogists, if it had not been deprived of it: from its appearance this coat must have been considerable, and has been chipped off with a chisel. The piece of silver was found in the mines of Quantacaia, situated on the borders of the South Sea.

Silver also is one of those metals which will deprive iron of that portion of oxygene which raises it from the minimum to the maximum, or which is comprised between 28 and 48 *per cent.*; but it is necessary to assist it by a certain temperature, for at a less temperature the iron recovers its oxygene: the following experiment proves it.

A solution of red sulphate was heated in a small matrass with some refined silver; a part of the latter dissolved, and the sulphate became green. It was filtered, and a little common salt added to it; the muriate was separated,

rated, and the filtrated liquor, or the sulphate of iron, was precipitated green by alkalies. But if the filtrated liquor had been retained instead of being separated from the silver, it would become filled with metallic spangles by degrees as it cooled. Now this new separation could not take place but inasmuch as the base of the green sulphate recovers the oxygene from the silver. This result ceases to surprise, if it be recollected that a solution of green sulphate mixed with another of sulphate of silver, instantly precipitates the metal in a brilliant powder. It is some time since I had occasion to observe that red sulphate cannot be concentrated in a basin of fine silver without being subject to similar changes.

Carbonate of Silver.

This carbonate, when obtained by that of potash, is of a yellow-white, but it will not keep; it blackens in the light, and gradually disoxydates; for if at the end of a year nitric acid very much diluted be applied to it, a portion of the silver in powder separates from it.

Sulphate of Silver.

Mercury poured into a solution of sulphate of silver decomposes it; and produces a crystallization which scarcely rises above the surface, and consequently it exhibits none of the pleasing phenomena of nitrate.

Tree of Diana.

Lemeri very properly recommends mercury to be poured into a solution of silver very dilute. In the small as well as in the large way, very beautiful and variable trees of Diana are always obtained. Hemberg and Beaumé, with their balls of amalgam and their dissolutions,

tions, have only rendered the operation complicated and disgusting to those who like to amuse themselves without so much trouble, with one of the most pleasing results of experimental chemistry.

TO BE CONCLUDED IN OUR NEXT.

Intelligence relating to Arts, Manufactures, &c.

(Authentic Communications for this Department of our Work will be thankfully received.)

Invention of a Bathometer.

M. Van Stipriaan Luiscius, M. D. has invented a Bathometer: an instrument with which, he asserts, the greatest depths of the ocean may be fathomed. He has already had it constructed in the celebrated manufactory of Messrs. Onderdewyngaart, at Delft. Should the matter be confirmed, which there is reason to hope, according to the testimony of competent judges, not only from the construction of the machine, but also from preliminary experiments made upon the river Maese, by the inventor, in presence of M. Van Bemmelen, Lecturer on Natural Philosophy at Delft, and of several nautical persons, we may justly expect to obtain new information respecting this subject, and the form of the surface of the earth in those concealed abysses of the sea. As, however such experiments cannot easily be undertaken by any others than sovereign princes, or opulent companies, M. Van Stipriaan Luiscius has resolved to send a well-constructed small model, made in the above-mentioned manufactory, to the principal naval powers, for farther experiment.

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List of Patents for Inventions, &c.

(Continued from Page 240.)

RICHARD TOMKINSON, of the town of Liverpool, in the county of Lancaster, Salt Merchant; for a machine, engine, or instrument, for making white salt, and preparing brine to make white salt. Dated August 1, 1806.

JAMES RAWLINSON, of the town of Derby, Gentleman; for certain improvements or apparatus commonly made use of as trusses or bandages for ruptures.
Dated August 1, 1806.

PETER MARSLAND, of Heaton Norris, in the county of Lancaster, Cotton-spinner; for an improved method of weaving cotton, linen, woollen, worsted, and mohair, and each or any of them by machinery.
Dated August 1, 1806.

THOMAS FRICKER, of New Bond-street, in the county of Middlesex, Paper-hanger, and RICHARD CLARKE, of Manor-street, Chelsea, in the said county, Paper-hanging Manufacturer; for a new mode of decorating the walls of apartments in imitation of fine cloth, without joint, seam, or shade, by means of cementing of flock on walls of plaster, wood, linen, or paper.
Dated August 1, 1806.

RALPH WALKER, of Blackwall, in the county of Middlesex, Engineer; for an improved mode of making ropes and cordage of every dimension or size, by not only making all the yarns bear equally in the strand, and laying the strands uniformly in the rope, but also by making the rope or cordage from the yarns in the same operation. Dated August 9, 1806.

JOSIAS

JOSIAS ROBBINS, of Liverpool, in the county of Lancaster, Millwright, and JAMES CURTIS, of the city of Bristol, Coppersmith; for certain improvements in boilers for manufacturing sugar, and in the mode of fixing the same, whereby much labour and fuel will be saved. Dated August 20, 1806.

JOHN BYWATER, of the town and county of the town of Nottingham, for an improvement in certain sails of ships, and other navigable vessels, and the mode of working the same. Dated August 22, 1806.

JOHN CURR, of Belle Vue House, in the county of York, Gentleman; for a method of laying and twisting the yarns that compose a rope; by which method the yarns of a rope have a better and more equal bearing than they have in a rope made in the common way. Dated August 23, 1806.

RICHARD FORD, of the city of Bristol, Ropemaker; for a new kind of cordage, made by a process intirely new, from old rope or junk, or such short ends of new rope as are now commonly converted only into oakum or coarse paper; by means of which process the objections to cordage usually termed twice-laid cordage are totally obviated, and the newly-invented cordage is made nearly equal to cordage made from new materials. Dated August 30, 1806.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LIII. SECOND SERIES. Oct. 1806.

Specification of the Patent granted to BRYAN DONKIN, *of Fort-Place, Bermondsey, in the County of Surrey, Engineer, and* HENRY MAUNDSLAY, *of Margaret-street, Cavendish-square, in the County of Middlesex, Engineer; for a new and simple Method of combining Wheel-work together, so as to produce any required Proportion of Velocity between the Weight and the First Mover.*

With Engravings.

Dated July 24, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Henry Maundslay do hereby declare, that our said invention is described in manner following; that is to say:

Fig. 1, (Plate XIII.) represents a set or system of wheels, combined, according to our method, into the form of an engine or apparatus for raising weights, to be used instead of the well-known engine called a crane. G, represents a small wheel or pinion turned by the first-

mover, applied to a handle, and giving motion to a larger wheel F. B and C, represent two wheels, having a common axis, upon which they are so fixed that, when one wheel is turned, the other must likewise turn with it. The axis passes through the wheel F. A, represents a wheel, which is fixed in its place, so that it cannot be moved or made to turn. D, is a wheel attached to the barrel E, which it carries round by rotation upon the axis I H.

Fig. 2 exhibits the outside of a section of the said apparatus, taken across the axis of motion. The operation or effect of the combination here described is as follows. When the wheel F is turned round, it will carry the axis of the wheels B and C along with it, and would cause those wheels to make one absolute rotation in each turn of the wheel, if the said wheels B and C were without connection with any other part of the apparatus. But, as the wheel B works by its teeth in the motionless wheel A, it will run or roll thereon, and will in each turn perform a quantity of rotation, amounting to as many of its own teeth, in angular measure, as shall equal the number of teeth in A, over and above the single rotation above mentioned, as produced by the revolution of the axis, which is carried round by the motion of F: whatever angular motion shall be performed by B, the same will also be effected by C. If therefore we, for the sake of illustration, make the before-mentioned supposition, that E should revolve without causing B to roll by any connection with A, the wheel C, if connected with D, and without any rolling motion, would carry D round once in every rotation of F, and D would thus move in the same direction as F. But, if we attend to the apparatus in its complete state, and admit that B shall roll upon the motionless wheel A, then C will have a rotation on that

that account, which, with regard to D, will carry its teeth at the place of connection in a direction contrary to that in which D was last supposed to be carried round: Whence it must follow, that the rotation of D in the complete engine will be equal to the difference between one entire rotation of D in the direction of the motion of F, and the quantity of rotation which is caused in D, in the opposite direction, by virtue, or in consequence, of the rolling of B upon the motionless wheel A; so that if A and D be made equal to each other, and B and C be made equal to each other, as shewn in the drawing, then the quantity of rolling motion will exactly counteract and destroy the effect which might have been produced by the rotation arising from the axis of B and C being carried round. But, if C be made less than B, the effect of the rolling motion will be less than the effect of the revolving motion, and D will be carried round in the direction of F through a space equal to the difference as aforesaid; which difference may consist of one single tooth, or of any greater number, according to the relative magnitude of the wheels to each other; and so, on the contrary, if C be greater than B, a motion will be produced in D in the contrary direction to that of F, with any desired velocity; and as the proportions of A and B to each other, as well as of those of C and D, are also capable of any required variations, it will be practicable to obtain any desired ratio of velocity, either quicker or slower, between the wheels F and D. And moreover it will be practicable in this (as is the case with every other mechanical engine) to reverse the situations or places of applying the first-mover, and the weight, by that means to obtain what is called power or purchase, or, on the other hand, velocity, as may be required when the apparatus itself is not intended to be altered.

Lastly. I do declare that the several parts of wheel-work, combined according to our said method, (the nature and principles of which may be understood from the foregoing description and explanation,) may not only be varied as to their respective and relative dimensions with regard to each other, but that the combinations, according to our said method, may be applied to give motion and effect to screws, capstans, lathes, and all other engines which act in the way of rotation. And the said wheels may be constructed of any fit material, according to the intended uses, and connected together by teeth, bands, stops, or chains, or any other method by which wheels or circular revolving bodies are made to drive each other; and the first motion may be given by any of the forces commonly used for such purposes.

In witness whereof, &c.

Specification of the Patent granted to RICHARD TOMKINSON, *of the Town of Liverpool, in the County of Lancashire, Salt Merchant; for a Machine, Engine, or Instrument for making White Salt, and preparing Brine to make White Salt.* Dated August 1, 1806.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Richard Tomkinson, in compliance with the said proviso, do hereby describe and ascertain the nature of my said invention, and declare that the plan hereof, drawn in the margin of these presents, is composed of the following particulars; that is to say: The principle of this invention is making white salt, and preparing brine to make white salt, by means of a hollow cylinder, or pipes connected together, or a passage

passage or passages, of any form, placed in the midst of the liquid; through which cylinder, pipes, passage or passages, the fire shall pass, as through a chimney, or in a similar manner to which water passes through pipes laid in the street for the purpose of supplying houses. The pan which is to contain the liquid may be made of any suitable materials, size, or shape, with a suitable cylinder or cylinders, or pipes of iron, metal, or other substance, which will withstand the force of fire, agreeably to the wish of the person or persons to use them; but the inventor recommends cast iron for the cylinder and pipes, similar with the plan annexed, and the description following.

The pan to be flat or horizontal, as described by the letters A, Fig. 3, (Plate XIII.) may be fifty feet long from C to D and E to F, and fourteen feet wide from C to E and from D to F; the sides from C to G, H to E, D to R, S to F, to be perpendicular, and about fifteen inches deep from the sides at G R E F, to meet in the middle nearly in an angle at the letters I, like a common water-spout, making it in the middle, that is, in a line level with the top edge on each side, where the two sides meet at bottom, as aforesaid, three feet six inches deep, (as far as the cylinder marked L, after described, extends in the mouth,) and two feet six inches deep, the remaining length thereof from O to P. The side and ends may be made of wood, the bottom of wood also, or of clay covered with tiles, bricks, &c. The fire-place is at K, placed in the cylinder L, which is of cast iron, and seven feet long from Q to O, of an oval, from two feet three inches deep and three feet broad in the inside. The cylinder is fixed in the centre of the front end of the pan at Q, the end of it level with the outside of the plank. Between the cylinder and plank it is caulked with oakum. The pipes, in as many joints as convenient, (marked with the

the letters M,) are of about nine to twelve inches interior diameter, and are joined to the cylinder at O, and pass in a line parallel with the angle at bottom I, and the distance of about four inches from the bottom, the cylinder being only about two inches from the bottom, pass through the other end of the pan at P (where they join a chimney). The heat and smoke pass through such cylinder and pipes, which may be supported on the bottom of the pan by as many bearers as requisite, so that the liquid can freely circulate under the pipes, and a scraper or rake can pass between them and the bottom; but the top surface of the cylinder and pipes should be upon a level with the bottom of the pan's sides at G R E F; and care should be taken always to have the cylinder and pipes covered with liquid on the mouth of the cylinder. At K there is a grate, and as many bars, and fixed on as many bearers, six inches from the bottom of the cylinder, as convenient, so as to leave sufficient space for the ashes to fall, and be raked off. The fire is not to come nearer than about six inches from the mouth of the cylinder, (on account of the wood-work,) so that the hatch, frame, and small iron door, as in common stoves, must be placed that distance at least from the mouth of the cylinder. Clear them as often as possible from the scales they are liable to contract from the liquid. There may be more than one fire, cylinder, and pipes, as may be required for the size or form of the pan, &c.

The inventor does not confine the patent to any size or shape of the pan, pipes, cylinder, &c. which may be made at pleasure; but wishes only to preserve the principle of the liquid by this means, always surrounding the fire, except just at the aperture, where it must be supplied with coals and fuel, and whence it communicates with the chimney.

In witness whereof, &c.

Specification

Fig. 3.

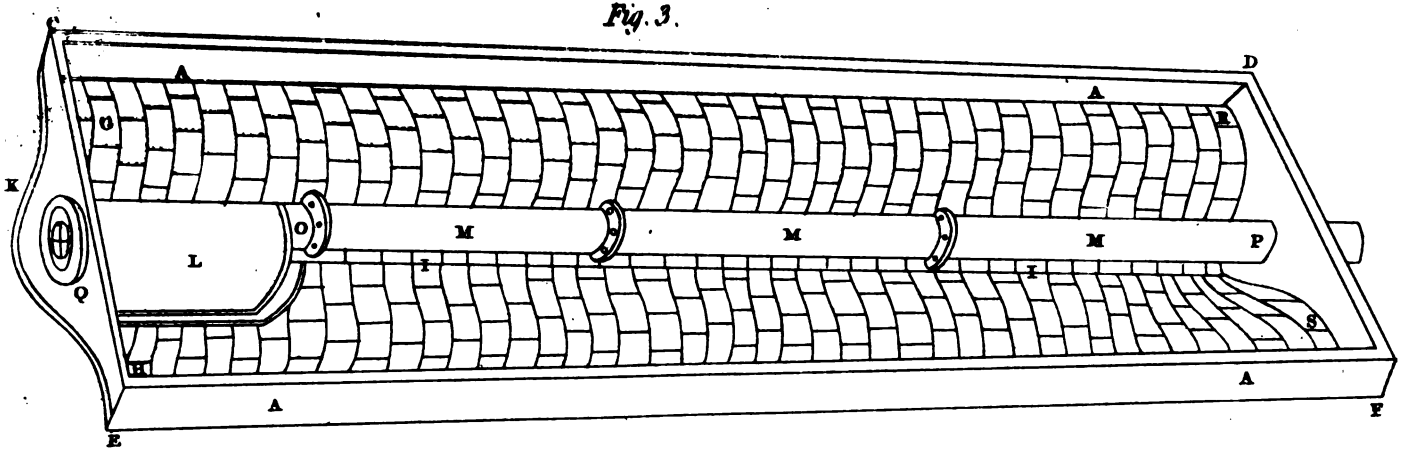
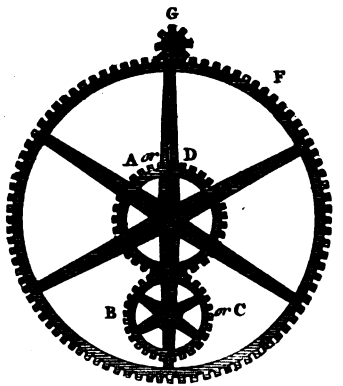


Fig. 2.



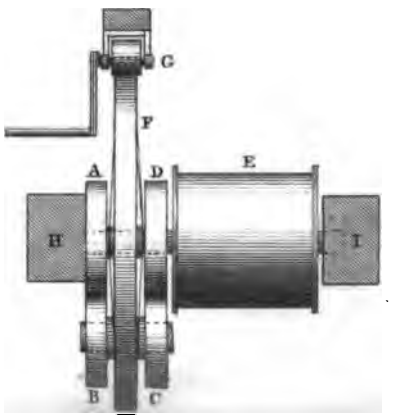


Fig. 1.

Specification of the Patent granted to THOMAS JAMES PLUCKNETT, *of the Parish of Christ Church, in the County of Surrey, Agricultural Machine-maker; for a Machine for dibbling and drilling all Kinds of Grain and Pulse.* Dated April 17, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Thomas James Plucknett, do hereby declare that my said invention, and the manner in which the same is to be carried into effect and practice, are described in the manner following; that is to say: As dibbling is now found to be the only effectual way to sow corn, pulse, &c. in order to insure crops and save seed, by which the farmer will save immense expense, and never be disappointed of a crop. It is made as follows, *viz.* A hollow roller, of about three feet diameter, the ends made of wood or iron, or other fit material, about one inch and a half thick. The roller about one foot long, made with bars of iron, about one inch and a half square, or any other fit material sufficiently strong, placed all round the circumference of the roller, about six inches asunder, or at any other distance at which it may be necessary to plant or dibble the corn, pulse, &c.; for the distance of these bars will be the exact space of one dibbled hole from the other following; therefore, these bars will be placed round the two heads of the roller at six inches distance from each other, or more or less, as may be required; these bars being about twelve inches long, secured, or otherwise fastened at each end, at about six inches asunder, to the two heads of three feet diameter, from what I above describe as a hollow roller. Through the centre of this roller is fixed a square axle, of either wood

wood or iron, or any other fit material, with only a sufficient round at each end for the round collar to work in, which will be either cut out of the ends or metal collars fixed to them. The square of the axle should project sufficiently through the ends of the roller to admit of fixing securely to them shafts or a handle, similar to a garden-roller or wheel-barrow, if a hand machine; but if made larger for a horse, it will be necessary to have shafts for the horse to draw in; in either case it must be so securely fixed on the square of the axle, that the roller shall turn freely about in the collars above described, by which means the axle becomes a fixture to the shafts or handle. On this square of the axle is hung a hopper or trough, within side the before-described hollow roller, of such dimensions as will hang freely, without any part of it being so close as to rub, or at any time touch, the bars or inside of the heads of the rollers. The mouth of this hopper or trough may be made to any convenient size within the hollow roller; but the bottom must be about two inches wide, and of nearly the length of the roller, made of iron or wood, &c. so that it is sufficiently strong to sustain the continued shocks of the bars, which will strike the bottom of the tumbler, which is fixed in the bottom of this hopper or trough. I call it a tumbler, because, as the bars strike the lower end of the upper part which is fixed in a mortise or groove in the hopper or trough, it is tumbled out of the mortise by means of being fixed through the middle by a pin at the bottom of the hopper or trough. The upper part within the mortise is the segment of a circle, about four inches diameter and about one inch and a half thick, or any other dimensions, as may be for the convenience of sowing large or small grain, or pulse, &c. This segment is so cut at the bottom of the hopper, that the centre is fixed just below the bottom,

bottom, outside the hopper, for the convenience of changing the segment agreeably to the size of the grain or pulse which is to be sown; for the segment of this roller, working within the groove or mortise which is cut through the bottom of the hopper, so that the seed is agitated by the tumbler on its own axis, will consequently never open any part of that groove or mortise, which will prevent the grain or pulse within the hopper from dropping out. And in order that it shall deliver or tumble out the same quantity at every time, the bars of the roller strike against the lower part of this tumbler, or small segment of a roller, which is fixed at the under side of the hopper. There must be cut out of the upper edge of the segment next the front of the hopper, a recess, of a proper size for that purpose, something in the shape of a bean, which must be sunk within the segment; at the same time taking care to preserve the edges of the thickness of the roller up to the segment; the corn, &c. will be liable to jamb between the mortise or groove and the side of the segment, therefore the form of the recess will be like the bowl of a tea-spoon, but smaller, or otherwise, as may be found necessary for the quantity of seed to be delivered. This recess being placed just within the thickness of the front of the bottom of the hopper, it will completely shut up the mortise or groove, until it is thrown open by the playing of the lower part of the tumbler against the bars as the machine is moved forwards, which will be at six inches intervals, more or less, agreeably to the portion of those bars which strike against the lower part of the tumbler, force it up in order for the bars to pass it; which must always be the case while the lower part of the tumbler is a little longer than the radii, as the bars revolve round its axis within the lower end of the tumbler. To the lower end of the tumbler is fixed a

prong on a joint, which will only open from the underside of the hopper so as to project perpendicularly downwards, and there be stopped by means of its joint revolving no farther round the lower part of the tumbler; therefore this being about two inches long, will strike the bars, but, when doubled under the hopper by means of the joint, the bars will pass freely by it without disturbing the tumbler, and consequently not let out any of the contents of the hopper, which is necessary to preserve the contents of the hopper from waste, by rolling the machine the reverse way to that when at work. I have called it above a prong, because this little swivel is fixed to the outside of the tumbler, with two ears, through which, and the bottom of the tumblers, is a little pinion, which it swivels at the lower end, which is about two inches or more, if necessary, is divided so as to make a prong above described; by which means the hole which the dibble makes will be filled up, and the end covered over, as the dibble will deposit the grain between the prong, which is drove into the ground at the same instant the bars lift the lower part of the tumbler and prong, because the dibble is fixed to the upper part of the segment; and consequently the segment being on a centre, the dibble must be fixed into the earth in the same proportion as the bars lift the lower ends, or more, as may be found necessary, by fixing one or the other, more or less, from the centre. The hind part of the dibble is hollowed sufficiently to convey the grain, &c. to the ground; the lower part is pointed and the front about the thickness of a coulter, because it has two motions, being struck into the ground and passing forward at the same time. The upper end is placed in an eye of iron, about as much above the joint as the point is below, fixed to the outside of the hopper, through which it passes freely

freely every time it strikes into the ground, which is done by the motion of the tumbler, which turns out the seed at the same instant.

The above is the most simple, and best suited to agricultural purposes, being the least likely to be put out of repair; and if at any time injured, so little complicated that it will be sufficiently within the capacity of any country tradesmen to repair it. Notwithstanding this instrument or dibbling machine may be made several different ways, and the principle still be the same, such as with cog wheels and plain round holes in the bottom of the hopper, which may be eclipsed by a slide and screw, to adjust the quantity to be delivered at each stroke of the bars against the ends of the small flaps or shutters, which are fixed on a hinge, and shut up the bottom of the hole every time by means of a spring wire inside, through the hole at the bottom of the hopper, which agitates the seed every time the bars pass, the ends of these shutters being a little below the bars, as above described, throw open the hole, and let out the seed the moment it is passed; it is again shut by the wire, which at the same time agitates the seed, and prepares for the next discharge. The dibble in this case may be fixed to each bar, or with a coulter, placed in a frame before the hole, to prepare a furrow as the machine is pressed forward.

The above is for the use of one man, and completely within his power; but if one or more horses, it is only necessary to make a larger and longer roller, and place several hoppers within side it, at such distances as are best suited to the country or lands where it is intended to be used, and which will be proper for the work of the number of horses to the machine. The whole of which machine may be made of either wood or iron, or partly of both, or any other proper material, if it is sufficiently strong for the purpose,

The machine may be varied in its formation; but the principle of dibbling, or placing seed in the ground, at equal distances, or nearly so, will still be by dibblers fixed to the roller, or as above described. These are the most plain and easy to be repaired in the country; yet I do not confine myself to these ways only, as the above-mentioned roller and bars may be made to drive a spring dibble first up the hopper or bin, and with a recess in the back of it, like the bowl of a tea-spoon, or any other form suited to that purpose, bring out of the hoppers the quantity necessary, and deposit it in the hole made by the spring-dibble at the hind part of it, which would be as regular as the bars strike the dibble point, which, by projecting a little below the bars, would be by every one driven up to let them pass, and, by means of the aforesaid described spring, would be forced into the ground, and deposit the quantity necessary at the same instant. The action of this dibble would be similar to the spring-bolt of a lock of a door, only with this difference, projecting perpendicularly downwards to the earth. This likewise can be made of any material sufficiently strong, iron, wood, &c. or partly of both, as may be found requisite. The roller may be made in halves, or a part of the bars to open, for the convenience of putting in the seed in hopper, bin, or trough; or the bars may be placed and secured round the heads of the roll after the hopper is fixed to the axle, as there will be sufficient space to put the seed in the hopper between the bars; however, it can be done either way, as may best suit the convenience of the person, and the levelness of the country where it is intended to be put in practice.

In witness whereof, &c.

Specification

Specification of the Patent granted to DAVID HARDIE, *of the Parish of Saint James, Westminster, in the County of Middlesex, Gentleman; for an Improvement in and upon Cranes for raising and lowering Goods into and out of Warehouses, &c. and which considerably lessens the Labour that is usually required to work them.*

With a Plate.

Dated March 8, 1799.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said David Hardie, in compliance with the said proviso, do thus hereby particularly describe and ascertain the nature of my said invention, and the manner in which the same is to be performed. The principle of the raising apparatus of my crane is to constitute the force employed, sometimes by the whole weight of the person or persons working it, sometimes by the whole of his or their weight, with the superaddition of his or their muscular strength, and sometimes by only part of his or their weight, without the superaddition of any muscular exertion; and also to oblige each person, in the case of a plurality of workmen, to perform his due share of the labour, not affording an opportunity for the appearances of exertion, without the reality, and forming an efficient combination of their respective efforts. And the principle of the lowering apparatus of my invention consists in applying a convenient quantity of water, or other liquid, to counteract the accelerating velocity natural to falling bodies; so that the weight lowering shall on no occasion descend with precipitation, but with gentle motion, at all times to be easily arrested by the common gripe wheel: both principles being attended with dispatch of business, saving of labour, and prevention of dangerous

dangerous accidents. The modes by which I vary these principles into practice are fully ascertained by the following description and references to the drawings, with remarks. (See Plate XIV.)

Fig. 1, a front elevation of the beam.

Fig. 2, an end elevation and section of the lowering apparatus.

Fig. 3, an end elevation of the barrel and tread wheel: the same references are put to the corresponding part of each figure.

This crane is composed of three principal parts: First; A A A A, a tread wheel, less than half the size of the walking wheel in common use, and of a worse construction with regard to the steps, which are outside instead of inside of the circumference of the wheel. Second; B, the barrel on which is coiled the rope *a a*, that is connected with the weight to be raised or lowered; *b b*, is a gripe wheel upon the axis of the barrel; and *c c*, a brake to gripe and stop the motion when necessary. Third; C C, the lowering wheel contained in the box or cistern *d d d d*, upon which stands a head or covering *d e d*, made semicircular, or otherwise, and made so slight as to be easily lifted off when required.

In Fig. 1 a vertical section of the cistern *d d d d*, and its head *d e d*, in the direction of their breadth, is represented; and in Fig. 2 a vertical section of the cistern and head, in the direction of their length, in order to shew the lowering wheel C C, composed of the eight spokes or arms *f f f f*; or they may be more or less, or of various other shapes, fixed to, and radicating from, the axis *i k*. These arms are made single and double alternately, as represented by the two shewn in Fig. 1, in order to produce a better effect when they strike and pass through the water or other liquid contained in the cistern

cistern *d d d d*; and the water or other liquid, to operate with its greatest power, must be kept neither higher nor lower than the centre of the axis *i k*, but its power is reduced in proportion as that quantity is diminished. Each of the aforesaid three principal parts of the crane is supported by turns upon its own shaft or axis, the three shafts being in the same straight line of direction; and the shafts *g h* and *i k* can be connected to, or disconnected from, the shaft *h i*, by means of a sliding box coupling at *h*, moved at pleasure by a lever or otherwise, and a ratchet wheel and click at *i*; or any other mode of coupling may be used.

The manner of using this crane, when the goods are to be raised, is to connect the tread wheel A A A A with the barrel B, by means of the aforesaid coupling; a competent number of men are to mount upon the steps *b b*, that occur a little above the centre of the wheel, it not being so convenient to suffer themselves to descend below that point; and laying hold with their hands of the rails *m m m m m*, fastened to the top of the framing of the crane, and projecting at a convenient height on each side of the men respectively, they are enabled on all occasions to maintain their proper situations on the wheel; sometimes to cause their whole weight only to operate, sometimes too superadding their muscular exertions to the whole of their weight by pulling the rails *m m m m m* upwards, which has the effect to force their bodies downward, and sometimes to support part of their weight on their hands, either for the purpose of diminishing the velocity of the wheel, or for giving ease to their legs when tired. It is to be observed, that, while they continue on the wheel, they cannot avoid giving the greater part of their weight towards producing the intended effect; as no person would long prefer supporting his weight by his

his arms rather than his legs; and that consequently an efficient union of their respective efforts is obtained. The tread wheel A A A A on moving round necessarily turns round the barrel B, and winds up the rope *a a*, raising the weight attached to it. The steps *n n*, marked on the brace of the framing of Fig. 3, which may be made variously, serve for men to mount or dismount upon from the tread wheel. The clicks or pawls O O, by falling into the steps of the tread wheel as it turns round, will prevent dangerous accidents from the weight overpowering the men. When weights are to be lowered, the tread wheel A A A A is to be disconnected from the barrel B. The click and ratchet wheel at *i* will connect the lowering wheel C C to the barrel B, and the descending weight will necessarily carry round the wheel C C the arms *f f f f*, (f which alternately striking on the surface of the water, or other liquid in the cistern *d d d d*, and forcing their passage through it, will counteract the accelerating velocity natural to falling bodies, producing a gentle motion of the weight, free from all danger of precipitation, and subject at all times to be arrested with ease and certainty by the gripe wheel *b b* and break C C. The rope *a a*, after being detached from the weight lowered, is brought up again by a sufficient counterpoise weight attached to the back rope *p p*, which had been wound upon the barrel B, as the rope *a a* descended. Thus the operation of lowering can be performed by only the attendance of one man to the crane; combining at once dispatch, a great saving of labour, and perfect security from all danger to men or goods.

Another mode of applying water, or other liquid, for the purpose of lowering weights, may be effected by putting the crank upon the axis *i k* instead of the spokes, and attaching to this crank a piston, which by the motion

Fig. 1.

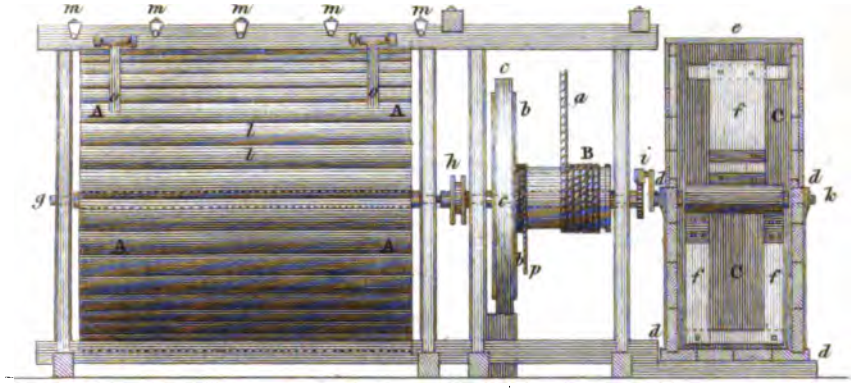


Fig. 2.

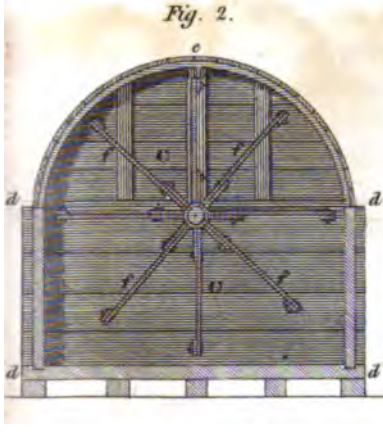
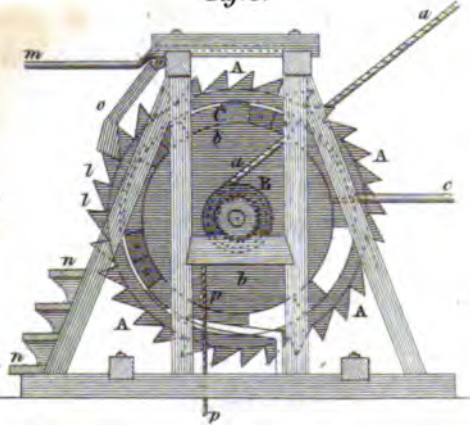


Fig. 3.



Scale.

tion of the crank is moved up and down in a box or cylinder filled with water, or other liquid, both ends of the cylinder being covered, and the piston rod moving through a stuffing box in the upper cover. An apparatus, regulated by means of a cock, or otherwise, being made in the piston, the water, or other liquid, is obliged to pass through this aperture as the piston moves up and down, and the velocity with which the piston can move will be in proportion to the size of the aperture. The upper cover of the cylinder may be formed into a small reservoir round the stuffing box, to receive the small quantity of water, or other liquid, that may be forced up through it. This liquid may again be easily introduced into the cylinder, by means of a cock, through the bottom of the reservoir, which is the top of the cylinder; and this cock may also serve as an opening to introduce an instrument to regulate the cock in the piston when occasion requires, without being under the necessity of taking off the upper cover of the cylinder for that purpose. Accuracy to the fitting the piston to the inside of the cylinder is not necessary, as a small quantity of the liquid that passes by the side of the piston does not injure the effect of the apparatus; or water, or other liquid, may be applied to the like purpose of lowering weights by various other ways. When the lowering apparatus is used for the purpose of lowering goods or persons from a building in case of fire, it will be proper to attach two ropes or chains to the barrel, winding in contrary directions, in order that the descent of one weight by one rope may wind up the other, to be in readiness to continue the operation.

In witness whereof, &c.

On the Nature and Properties of Manures, and the Mode of preparing and applying them to various Soils. By ARTHUR YOUNG, *Esq. F. R. S.*

(Continued from Page 276.)

CHAPTER III.

Of Fossil Manures.

THE substances most commonly purchased as manures in this kingdom, of this nature, are few. There are none that demand attention, except

1. Coal-ashes.
2. Salt.
3. Gypsum.
4. Lime.

The first of these, for reasons already given, has been classed with other ashes, and the fourth treated of in the first division of this memoir.

§ 1.—*Of Salt.*

By various experiments, and by observations made apparently with care, but too numerous to be detailed *, it is decided, that sea-salt acts as a manure in some cases to a degree that proves its excellence, when properly applied. I am aware that other persons have reported unfavourably of it; but the general knowledge of this manure is in its infancy, for want of more trials being satisfactorily made. Several prove that the quantity applied should be very small, and that quantity is not ascertained.

* To render these papers as brief as I can, I shall only refer to the authors who report this fact. Roalfe's Addenda to Manures, 4 to 35. Hunter's Evelyn, p. 48. Bishop Watson's Chemical Essays, vol. ii. p. 75. Wight, vol. i. p. 246; vol. iii. p. 302. Baker, p. 15. Boerhaave, p. 106. Hollingshead, pp. 27. 58. Communication to the Board of Agriculture, vol. i. p. 361. Annals, vol. i. pp. 147. 260; vol. iii. p. 19; vol. v. pp. 149. 527; vol. xxviii. p. 200, and many others.

Errors

Errors therefore may easily be made in this, as well as in other points, and cause those unfavourable reports which more care and attention would have prevented. I have, during several years, made experiments on this substance, and scarcely one that did not tend to convince me of the fact, that it is a powerful manure; and especially when added to any dung or dunghills; and I was so much convinced of the fact, as to strew a small portion to all yard-manures at the time of filling.

If with these facts of practice we combine certain chemical ones remarked by eminent writers, we shall not hesitate upon the point, but clearly perceive that such results are conformable to the *nature* and *properties* of this substance.

"The application of sea-water to vegetables generates putrescent hepatic gas, caused by the mixture of vegetable juices with the vitriolic neutral salts contained in sea water. Muriate of magnesia forms one-fourth of the saline matter of sea water. Very considerable benefit has been experienced from its use in promoting vegetation, when mixed with dung or compost dunghills. It possesses a septic power that promotes putrefaction *."

"One hundred parts of sea-salt contain fifty-three parts of alkali (soda) and forty-seven of acid †."

"Sea-salt acts probably as an assistant to putrefaction ‡." "One ounce in twelve accelerates that of animal substances §." "The conversion of sea-salt into an alkali by putrefaction, leaves no room to doubt of its benefit ‖."

André and Parmentier are against salt, and yet prove that putrefaction decomposes muriatic salts ¶. Did they ever try soda?

* Lord Dundonald. † Kirwan. ‡ Bishop Watson.
§ Pringle. ‖ Medel. ¶ Senebier.

a thin layer on the surface of a dunghill, to retain the gaseous effluvia which would otherwise be dissipated, this also is right; but it bears not upon the enquiry.

It is said that certain substances promote fermentation, *therefore* I would not add them. Fermentation yields the gases which fly off into the atmosphere; the nose explains this sufficiently. If unfermented substances were annihilated under the furrow, previous fermentation would be necessary; but we know that the contrary is the fact; and that not an atom is lost. By mixture a *tertium quid* is sometimes formed, but nineteen times in twenty this is gaseous and dissipated. The only rational pretence for a compost is in order not to *gain* any additional substance. But to get *rid* of an evil; suppose the mud out of a pond is found to be steril from acidity, it would be right to add potash in any of its forms, or lime, or chalk; but here ends the benefit of composts. I do not admit, till experiments are more decided, that the circumstance extends to peat. It is at least doubtful, as the application of the substance has been found highly beneficial without any such mixture. I know of no experiments that are in the least decisive of advantages, which may not be fairly attributed to the separate and detached application of the substances mixed. I have not been inattentive to that mass of ingenious theory, the Chapter on Manures in Darwin's Phytologia; some passages in which might be quoted against these ideas. But I conceive, the only possibility of promoting science is to rely on facts, and to confine theory to conclusions drawn from them.

However, I like so little mere reasoning on any agricultural question, that I shall not extend these observations.

On the Food of Plants.

All organized bodies are resolvable into hydrogen, nitrogen, oxygen, carbon, phosphorus, and sulphur.

Mr. Berthollet's great discovery, that the essential difference between animal and vegetable substances is the former containing nitrogen, the latter none *, reduces the list of component parts.

By a series of well-known experiments of Ingenhouz, Senebier, &c. oxygen appears as it were to be excrementitiously thrown off by vegetables in sun-shine, to the great purification of the atmosphere for the use of animal respiration, in which operation the vegetable decomposing a noxious gas absorbs what would injure respirable air, and leaves that which benefits it: a remarkable instance of that Divine Wisdom, which appears the more clearly in proportion as the works of creation are examined.

From experiments extremely numerous, and observations made by eminent chemists, it appears, that the two substances which play the greatest parts in vegetation, are hydrogen and carbon. The presence of light and heat is always to be supposed.

In the list of manures which have been detailed in the preceding chapters, some have been noticed as acting mechanically, giving either friability or tenacity, or powers of promoting fermentation; the product of which is carbon or hydrogen. Those which actually feed vegetables abound with, or are reducible to, these substances.

The importance of water in vegetation needs not to be insisted on. The immediate decomposition of this com-

* It is a constituent in a few plants.

pound

pound substance by vegetables has not been clearly elucidated. But Senebier notes the great probability that the hydrogen combining with carbon forms oily and resinous matters; and we know that oxygen is thrown off by leaves. Chaptal and Dr. Pearson expressly declare this decomposition. Of these two substances, hydrogen and carbon, of such undoubted importance, to which of them are we to assign the great effects observable from their application? Hazenfratz and Mr. Kirwan are decided for carbon. But Dr. Pearson combats the idea, and contends, that there is no evidence of carbon proving nutritive but when it is united to hydrogen and oxygen in vegetable matter; or to oxygen, hydrogen, and nitrogen, in animal matters.

Experiment has shewn, that water impregnated with carbonic acid is beneficial, and that carbonic acid gas has had a good effect. The conclusion to be drawn is not decisive; for in all these trials hydrogen might, and probably did enter.

It appears, by many experiments, that the fertility of soils is in proportion to the quantity of hydrogen gas they yield in distillation; and the efficacy of manures is pretty much in the same proportion. Powdered charcoal distilled yields a great quantity of hydrogen gas.

Hydrogen gas, obtained from filings of iron by sulphuric acid, I have often found highly beneficial to vegetation. I do not assert that even in this case it is positively free from carbon, but the quantity is by far too small to permit the effect to be attributed to that substance.

An observation of Fourcroy throws no inconsiderable light on this subject. "Charcoal," says that eminent chemist, "decomposes water, having a greater affinity with oxygen than that has with hydrogen."

The

This circumstance explains much of the difficulty which attends the insolubility of charcoal in water: Mr. Kirwan says, that the grand desideratum is to discover the means of rendering charcoal soluble in water. Dr. Ingenhouz says, that it is totally insoluble, and almost unalterable. But it is evident, from the observations of other chemists, that some bodies exist possessing this power. Potash has this effect, according to Mr. Thomson *. And Mr. Davy and Senebier remark the same thing of pure alkalies, but not when combined with acids. Dr. Darwin also remarks, that "carbon absorbs with great avidity all putrid exhalations. These consist chiefly of ammonia, hydrogen, and carbonic acid, and are the immediate products of the dissolution of animal or vegetable bodies. Hydrogen and nitrogen produce ammonia, which, combining with carbon, may form a hepar carbonis; and by thus rendering carbon soluble in water, may much contribute to the growth of vegetables." In another passage Senebier says, "he has found it insoluble in water; and that alkalies alone have the power of dissolving *some particles*." Mr. Davy remarks also, that "charcoal and water in a bottle give out slowly some heavy inflammable air." Here is the interesting circumstance: if the solution of charcoal in water, whether by time, potash, or contact with soils, be attended with the extrication of hydrogen gas, no wonder that charcoal should act as a manure.

I have now before me four and twenty tumblers of water, with plants growing through pierced cork floats. Different substances are added to each; among others charcoal, which evidently acts as a powerful manure. But the superiority over the glass which has no addition, is nothing in comparison with that of plants in another ap-

* Chemical Essays, vol. iv.

paratus, in which hydrogen gas, from iron filings and diluted sulphuric acid, is thrown up to the roots every day. The superiority here is striking to every observer.

That there is still some difficulty must, however, be admitted. Chaptal observes, that gas extracted from a mixture of sulphuric acid and iron, holds more or less of charcoal in solution, because iron itself contains it *. The desideratum seems therefore to be the application of hydrogen, free from carbon, as the means of really ascertaining to which substance the effect is to be attributed.

In what degree hydrogen is contained in, or formed by, other substances which act as manures, is an enquiry of great importance. It is remarked †, that sulphurated hydrogen is the base of the muriatic acid. Berthollet gives hydrogen as a component part.

No ammonia in fresh, but much in fermented urine ‡. One-fifth of ammoniac is hydrogen gas §.

The salt obtained from plants does not consist wholly of potash. Sulphat of potash, muriat of potash, sulphat of lime, phosphat of lime, are found in the ashes ‖.

Potash is composed of lime and hydrogen; soda, of magnesia and hydrogen ¶.

Magnesia is composed of lime and nitrogen; consequently of carbon, hydrogen, and nitrogen ↓.

Gum is composed of oxygen, hydrogen, carbon, nitrogen, and lime **.

Oils are composed of carbon and hydrogen ††.

By putrefaction, hydrogen gas is emitted in abundance.

Connection between inflammability and sulphuric substances.

* Senebier also observes, that *iron* enters into the composition of inflammable air.

† Manchester Memoirs, vol. v.

‡ Fourcroy. § Berthollet. ‖ Thompson. ¶ Guyton.
I bid. ** Thompson. †† Lavoisier.

If

If these combinations be well considered, it will appear that hydrogen is found in a very considerable number of substances which are used as manures; and that there may be some difficulty in finding a single one that does not contain, emit, or attract it.

The time allowed by the Society would not admit of much exertion, except in the closet. It was incumbent, however, on a candidate to do what the short period permitted. I therefore formed the plan of some trials which might possibly throw a certain degree of light on the most interesting of these enquiries.

First. The question relative to long and rotten dung appeared particularly interesting. I therefore compared straw cut into chaff, and applied to earths in different circumstances for barley; and the earth without any manure producing grain as 9. The straw steeped three hours in fresh urine produced as 50; steeped fifteen hours, produced as 63; steeped three days, produced 126; and applied dry, produced 39. In weight of straw and grain, the plain earth giving 48; that of three hours, 120; that of fifteen hours, 130; that of three days, 300; and dry, 100.

The result relative to urine is such as might be expected. But that dry straw should so much increase the produce, seems to prove, as clearly as one experiment can do, that every atom of vegetable matter in the soil begins to be decomposed immediately, and to want no previous fermentation in order to enable it to feed plants.

Second. Such eminent chemists have assigned to carbon so much importance as the food of plants, and its solution in water considered as a desideratum, that I compared it under different applications. The plain earth giving as above 9 and 48; dry powdered charcoal gave 26 and 90. Pearlash and charcoal in equal quantities, mixed and applied dry, gave 46 and 100. The

same mixed in equal quantity, and shook in water, gave 28 and 115; but the pearlash being applied, as I conceive from different trials, in too large quantity, killed four-fifths of the plants. Had this not been the case, the proportional produce would have been 140 and 575. The result in any case remarkable, pearlash being named by the chemists as having *little* effect in dissolving charcoal; *thus applied* to the soil, it seems to have had a very great effect. I should have remarked, that though pearlash, applied either alone or with charcoal, might easily be hurtful by an over-dose, yet this was not the case with the nitrate of potash, (pearlash and spirits of nitre in equal quantities,) which greatly promoted vegetation, giving 82 and 185; common nitre, 35 and 84.

Third. The result of various experiments on gypsum, in different countries, having been extremely contradictory, I was anxious to analize its proper application. The earth, without addition, giving as above 9 and 48; gypsum alone added gave 61 and 160. And in another experiment applied in water, it doubled the force of vegetation. These results were very contrary to my expectation.

Fourth. The accounts we have had of common sea salt are as contradictory as that of gypsum. The plain earth yielding as above 9 and 48; salt alone, applied in different quantities, gave 40 and 96, 50 and 120, and 28 and 90, 36 and 100, 31 and 70; but with addition of chalk it gave 68 and 175, and 40 and 120 *. The result upon the whole very decisive.

* The soil in which the trials were made, on being analized, was found to consist of (500) grains:

Sand - - - - - - - -	136
Clay - - - - - - - -	364
Carbonate of lime - - -	0
	500

Iron a strong impregnation.

Fifth.

Fifth. At the same time with the preceding trials, some other substances were under experiment. The plain earth giving, as above-mentioned, 9 and 48; soda gave 81 and 210, a remarkable result; bay salt 63 and 149; iron filings, 40 and 100; magnesia, 40 and 120.

If it be asked, what is the practical use of such disquisitions? the premium offered by the Society answers the question. Is it conceived that so enlightened an assembly of patriots want to be informed that dung, and marle, and lime, and night-soil, and malt-dust, act as manures? And would they demand an account of the *nature and properties* of substances, if the common knowledge of every sensible farmer was all they required? Their views are evidently more extensive, and more philosophical. The more carefully these substances are analized, and the more intimately we examine the effect of combining them with different soils, the better will this branch of agriculture be understood. This is to be effected only by the application of chemistry, going hand in hand with the vegetating process. Very few chemists have been farmers; we can therefore do no more than combine the facts discovered by one set of men, with the result of the observations made by another set.

But *vires acquirit eundo*, knowledge advances; and the turning the attention of curious enquirers to the subject, in the manner which the Bath premium, it is to be hoped, will excite, cannot fail of throwing some light on a subject which will demand an age of experiments fully to elucidate.

Facts relating to the Chemical History of Gold.

By Professor PROUST.

(Concluded from Page 306.)

Effect of the Acids upon the Purple.

IF we apply to 100 parts of well-dried purple very weak aqua regia, such as what is made with marine acid, of 4 or 5 degrees, and a few drops of nitric acid, we see them lose their colour very speedily, and give a solution of gold. This solution, precipitated by the sulphate of iron, gives 24 grains of fusible gold. The oxyd of tin which remains amounts only to 70, which shews that the aqua regia has dissolved 6 grains. It is white, vitreous, like every oxyd at the maximum. This result shews that the gold, as it is precipitated, carries with it a quantity of oxyd equal to three times its weight; and as 76 parts of oxyd at the maximum correspond to about 72,5 of oxyd at the minimum, it is probable that this is the portion of oxyd minor which can charge itself with the oxygene capable of oxydating twenty-four grains of gold.

If we pour a portion of muriate at the minimum into aqua regia, the oxyd passes into the maximum, but it is not precipitated even by the action of heat. When the gold, in abandoning its solvent and being converted into purple, carries with it in its precipitation so considerable a portion of oxyd, this result must again have been governed by an affinity.

Muriatic acid of 10 degrees, held in ebullition upon fresh purple, decomposes it gradually, and reduces it to the state of pure gold. The force of aggregation attaches its molecules again to each other, and unites them in small balls, which now exhibit only the colour of gold precipitated by iron, the sulphurous acid, &c.

The

The acid cleared by deposition is a solution of tin at the maximum, with a slight yellow tinge. A plate of tin causes this tinge to disappear, but gives no indication of purple.

The nitric acid of 32 degrees separates tin from the purple, and brightens its colour. This is the freshening process proposed by Lentin; but it does not effect its reduction into pure gold, however long the ebullition be continued.

The nitric acid, decanted off, contains tin at the maximum, and a small quantity of gold in solution. A few drops of muriate immediately demonstrate its presence.

This purple, the brightened tinge of which resembles that of cinnabar, always contains tin. Aqua regia easily demonstrates its presence in it. If we place it between the eye and the light, we perceive by the blue cast that the gold begins to be mixed with the purple.

Watery sulphurous acid also brightens the purple, because it separates from it a small quantity of tin, but its action does not go farther.

The sulphate of tin at the minimum likewise precipitates gold in the state of purple of Cassius.

Of the Precipitation of Gold by some Vegetable Juices.

I have shewn upon a former occasion that there are few vegetable juices, whether of an acid, gummy, saccharine, extractive, &c. nature, that do not possess the property of disoxydating gold; but among the extractive and colouring juices there are many which unite with this metal, and form with it purple lakes, of a deep, and frequently even of a very beautiful colour. Such unions confirm more and more the dispositions which gold has to form combinations of a peculiar order.

Let

Let solution of gold be poured into a well-cleared solution of dragon's blood; let the lake deposit itself, and after washing it several times with boiling water let it dry. This lake is a compound of metal and of colouring matter, united with each other by a real combination.

If we burn 100 parts of this lake, and fuse the ash with a little borax, we obtain a button of gold, weighing 40 grains. The quintal of gold therefore carries with it 250 parts, or 2½ times its weight of colouring matter. The following facts prove, 1, that the gold is in the metallic state; 2, that a combination exists between the two substances.

Water is a solvent of the principles which are contained in the dragon's blood; and yet water takes up nothing from the auriferous lake. Alcohol, which perfectly dissolves dragon's blood, likewise takes up nothing from this lake; it does not even assume the slightest tinge. Potash separates from it a large portion of colouring matter, but it does not completely deprive it of it, for there remains always a lake of a very beautiful purple colour, in which we still find the gold united with colouring principle. Three applications of potash were insufficient to reduce the gold to its pure state.

Ammoniac separates colouring principles from it, but does not dissolve it.

Muriatic acid of 10 degrees, has not the slightest action upon this lake, even when it is fresh. The gold therefore does not exist in it in the state of oxyd.

The nitric acid attacks it, and is decomposed, with a formation of nitrous gas, &c. and the lake, by the destruction of the colouring principle, is reduced to pure gold.

The juice of pine-bark, which is used in Spain for tanning leather, also affords a lake similar to the preceding, and

and exhibiting the same properties; but it does not contain more than $\frac{3}{100}$ of gold.

Gold in the metallic state may therefore form combinations with the colouring parts of vegetables.

Of the State of the Gold in the Purple applied to Enamels.

We have seen that the gold is in the metallic state in the purple of Cassius; but is it so likewise in the colours which it gives to glass and enamel? This is a question which it is time we should endeavour, if not to resolve, at least in some degree to illustrate.

The painting of purple colours with gold, oxydated or merely divided, has long been practised in Europe. The artists of the century before the last, employed indiscriminately for this purpose, fulminating gold, the oxyd precipitated by the liquor of silex, gold disoxydated by tin or by mercury, gold ground with pumice-stone, &c. Since then Homberg and Macquer remarked, that this metal gave a purple tinge to the vitrified parts of the substances on which it was supported, while under the focus of a concave mirror, Rouelle and Darcet, that gold struck by the electric spark also gave this colour to enamel.

From the time of Stahl to the discovery of the nature of oxydation, chemists were divided in their opinions respecting the nature of the purple: some considered it too repugnant to theory to admit that the gold, provided with all its phlogiston, could dissolve in the glasses, and alone exhibit an instance of a combination of which the other metals furnished no example. They therefore concluded, that it was capable of colouring the glass only in proportion as it was dephlogisticated; and Macquer could not avoid acceding to this opinion. Nevertheless it appears, he says, that it is a species of calcination

which renders the gold capable of entering into vitrification.

The rest, with Orschal at their head, observing on the one hand the facility with which gold, simply reduced to a state of great tenuity, gives this colour, and on the other the low temperature at which its oxyds return to the metallic state, concluded that nothing more was required in order to adapt it for painting than to reduce it to a state of extreme division. Macquer himself at last admitted this second opinion, and was the first who in plain terms asserted, *That all these facts prove, that the purple colour is natural to gold whenever it is in a state of extreme division.*

I shall, however, point out to the attention of chemists, some facts which may help us to determine which of these two opinions is the most conformable to truth.

Silver is not susceptible of oxydation by the mere heat of our furnaces. The extreme facility with which it returns to the state of metal, when it has been oxydated by the acids, is another difficulty to be overcome. Nevertheless, when an easily-vitrifiable substance can dissolve the oxyd in proportion as it is formed, the oxydation favoured by this attraction becomes permanent: it then supports a heat, which is no longer capable of reducing it. Of this the application of silver in leaf to glass, the combination of its oxyd with the phosphoric or the boracic acid, afford well-known proofs. The case appears to be the same with regard to gold; if a vitreous surface can dissolve its oxyd in proportion as it is formed, its reduction is retarded, and the purple is maintained till a higher temperature forces it to abandon its oxygen.

But the following fact, which is well known in the manufacture of glass, seems to decide the question. If any precipitate of gold be dissolved in fine crystal, there results

sults a brilliant glass, without colour, and of the most perfect transparency. Shall we say that the gold is merely divided in this glass? If we heat fragments of it in a retort, consequently far from any dephlogisticating vapour, they assume a magnificent purple tinge, without losing any thing of their transparency. Can we consider this result as metallic reduction? The purple of enamels, of painting upon porcelain frequently disappears, and appears again with the greatest facility. Do we here recognise a metal which never deviates from the metallic simplicity in the different states? The gold dissolved in glass gives colours or gives none. There we have a phenomenon in the history of this metal, the ætiology of which we do not comprehend. Let us therefore candidly confess with Macquer, *This purple state of gold is not yet well understood.*

Facts relating to the Chemical History of Silver.

By Professor PROUST.

(Concluded from Page 318.)

Acetate of Silver.

DISTILLED vinegar dissolves the oxyd of silver very readily, and yields long white needles, which crystallise easily. When heated in a retort it produces radical vinegar, gas, charcoal, and pure silver. I have not examined it any farther.

On the Surcharge that Muriate of Silver produces in parting Cornets. By Don Domingo Fernandez.

Having occasion, in the month of December, 1794, to assay twelve pieces of gold coin, I was astonished to see the twenty-four cornets come out with a surcharge of half a

grain more than they ought to have, according to the standard. I repeated the assay with the greatest care, and the result was still the same. That I might elucidate these appearances, I examined very particularly the lead and the acids that I had been using; but I perceived nothing that could account for such an extraordinary surcharge.

I had therefore no alternative but to return to the silver; but, as this metal proceeded from a muriate reduced by potash and charcoal, I was far from suspecting that it would have any influence on these results, especially as it was drawn by the rollers into very thin leaves, and without apparent defects. Being unwilling, however, to announce that these coins were half a grain above the standard without a fresh experiment, it occurred to me, to dissolve separately the twenty-four cornets in aqua regia; and the dissolution was hardly completed, when I at length discovered the cause of the phenomenon.

Each of them left a white powder, which I collected to examine, and I had no difficulty in recognising the muriate of silver, which was exactly of the same weight, from each of the cornets.

After this discovery I proceeded to examine the quality of my silver; I dissolved it in nitric acid, and the muriate separated from it instantly. Therefore it is certain that this salt is not *always* entirely decomposed in the reductions of it that are made with potash, and that it can incorporate and even dissolve in the metal without occasioning any sensible diminution of its ductility, since it may be drawn through the rollers without any apparent defect of continuity in the leaves.

I recommenced my experiments, but with pure silver, taken likewise from the muriate, and the surcharges disappeared. In consequence of this observation I determined

mined to dissolve the cornets whenever I may have reason to suspect extraordinary surcharges.

Nitrate of Silver.

The acid which is raised during the concentration of the solution, however moderate the ebullition, always contains a portion of silver, as muriatic acid instantly discovers. This result, which I have frequently ascertained, has certainly in some degree diminished the confidence hitherto placed in the method of assaying ores by nitric acid; and it is well known that it is indispensably necessary to boil it long enough to reduce the last portions of sulphuret of silver.

Nitrate of silver does not appear to contain water of crystallisation any more than saltpetre. It may be kept melted in a retort for some time without losing more than $\frac{1}{100}$ of its weight. As it cools it forms into a crystalline mass, rather grey, which is what is commonly called *Lapis infernalis*. This nitrate, when heated till it is entirely decomposed, leaves ,64 of pure silver, which is under the supposition that 100 parts of silver will yield 140 of nitrate.

The quintal of silver requires from 9¼ to 9½ of oxygen to serve as a base to the nitrate, according to an experiment I formerly made; however, it would be well to be re-assured of it.

This nitrate is therefore composed of from 69 to 70 of oxyd of silver, and 31 to 30 of nitric acid.

On the Assaying of Silver Ores.

Care must be taken to precipitate the solution with copper; as several authors have recommended. But notwithstanding the greatest possible care, a little of the silver

silver always remains in the liquors, as is shewn by the muriatic acid.

An ore which yields 10 *per cent.* by the dry way gives by precipitation only 8¼, 9, &c.

The following is a Method imitated from large Works, which is practised by M. Sage, *and appears to me to be preferable to all others.*

A quintal of calcined ore is melted with as much litharge, and three quintals of common carbonate of potash, in a crucible, the bottom of which is covered by throwing into it from 24 to 30 grains of charcoal, and a little oil, and which may be applied with the finger to the bottom and up the sides to half its depth; the cover is put on without being luted. Thus two crucibles are placed beside each other in a common furnace; the bellows are not necessary, and it is covered with charcoal. When the mixtures begin to melt, which is easily distinguished by the ear, the charcoal is so placed that the cover can be raised to see what passes. If the effervescence cause the mixture to rise above half way up the crucible, the cover is taken off; by this means the weight of the air confines the intumescence, and preserves it from extravasation. When the fusion becomes tranquil, the covers are replaced, covered with charcoal again, and then left till it is cold. If the assays have been well melted, the lead proceeding from them does not vary so much as two grains. By cupellation buttons are obtained, which ought not to differ more than the sixteenth of a grain. A sixteenth represents an ounce in the quintal; but if the ore be so poor as to give less than an ounce, (which is the case with most American ores,) at least 400 grains of real ore ought to have been taken.

Nitrate

Nitrate of Silver at the Minimum.

A saturated solution is boiled on some silver powder, that, for example, which is produced by the usual mode of parting; the ebullition is continued for an hour after all the nitrous gas has ceased. The liquor is then decanted with its deposit, and left to clear itself. The clear liquor is afterwards drawn off with a syphon, and is passed into a retort, containing some fragments of fine silver at the bottom, if it is intended to be concentered; if not, it is kept in a flask.

But the refined silver must be purified before it is used, in order to avoid the mixture of copper. To do this, the powder is boiled in a solution of silver, saturated, and slightly diluted: the copper changes into nitrate, and the silver comes out so far pure as not to alter the colour of fresh nitrate of silver.

The solution is of a clear yellow, not changeable; it may be concentrated much more than the nitrate at the maximum, without any fear of its crystallising, because what it produces is infinitely more soluble. When it is to the water as 240:100, it is still far from crystallisation; sometimes it remains liquid for several days; but when it is poured out of the retort it congeals so rapidly that the last portions adhere to the neck like icicles: a good deal of heat escapes during this congelation.

During the concentration of this nitrate a little is always volatilised. This passes from the minimum of oxydation to the maximum; sometimes also it is discovered to be a mixture of the two nitrates. In the first case, ammonia does not change the transparency of the produce: in the second, the fresh nitrate is indicated by a black colour.

It is difficult to make it crystallise regularly, because it has a greater tendency to congeal than to form into detached crystals. If it is congealed, it cannot be dissolved again without precipitating a yellow powder, which makes it necessary to suspend the operation, to give time for the powder to deposit, to draw the clear liquor off, and to put it into the retort again. It is true this inconvenience may be avoided, by sharpening with acid the water which is to redissolve the mass, because the yellow deposit is redissolved; but one is also exposed by this addition to increase the oxydation of a part of the nitrate, and to convert the produce into a mixture of nitrate *major* and *minor*.

The yellow precipitate of which we have been speaking is a double nitrate to the minimum of oxygen and of acid. The cause of its formation is, that one part of the fresh nitrate cannot be dissolved in water without taking from the other a little of its acid; and this loss of acid which the second part suffers, forces it to precipitate. These effects are perfectly analogous to those of nitrate of mercury at the minimum of oxydation, when it is poured into water. If it does not divide into two parts, and if one part does not borrow some acid from the other, this likewise does not dissolve; but in the case of which we are treating, as in that of mercury, the little remaining acid sets the yellow precipitate afloat, increases its saline state, and consequently renders it dissoluble.

It may, however, be crystallised by suspending and resuming the distillation successively, until by repeated trials the liquor is brought to the desired point. But I have not yet been able to obtain crystals sufficiently isolated, and out of the retort for convenient examination.

Properties

Properties of this Nitrate.

Its solution when kept from the air, and defended from the dust, loses its colour, and in a few days produces great square leaves of common nitrate, the base of which is at the maximum.

It is amusing to see the promptness with which a few drops of nitric acid poured into this solution form large leaves of nitrate. The liquor passes from white to yellow, ammonia blackens it, and in the end it is only nitrate at the maximum. If the acid be mixed with the solution more diluted and heated, the nitrous gas appears, and confirms the changes which the theory indicates.

Muriatic acid, when poured into a solution of nitrate *minor*, produces a muriate, the base of which arrives at the maximum instantly. Therefore there is no such thing, or rather I have not been able to form muriate at the minimum. The following are some of its most remarkable properties when mixed with re-actives.

A solution of common nitrate of silver and turnsol water produces no effect: with nitrate at the minimum it assumes the colour of lac blue.

Nitrate *major* and cochineal produces a scarlet: with nitrate *minor* a deep lac violet.

Nitrate *major* and a sulphuric solution of indigo, no effect: with nitrate *minor* it is entirely discoloured, and the silver is reduced.

Nitrate *major* and a spirituous tincture of fecula of hemlock, (which is the colour of a dead leaf,) no effect: with nitrate *minor* the green revives, and beautifies in a remarkable manner.

With Ammonia.

Ammonia precipitates the nitrate *minor* of a black colour: the precipitate when collected is pure silver, which

does not fulminate so long as it is kept under the ammonia.

The ammoniacal solution therefore holds some of the oxyd at the maximum in solution; for if it be saturated with very weak nitric acid, ammonia no longer blackens it. This shews that the portion of oxyd which is dissolved in the ammonia, rises to the maximum at the expense of that which precipitates.

With pure Potash.

A brown precipitate, similar in colour to that which is produced by the nitrate at the maximum. Re-dissolved in nitric acid ammonia produces a black precipitate, which demonstrates that the oxyd has not changed its state; but by drying it absorbs oxygen from the atmosphere, rises to the maximum, and does not differ from that which nitrate *major* produces.

With Alcohol.

Alcohol acts upon its solution like water itself; one part of the nitrate, deprived of part of its acid, separates in a yellow powder. The alcoholic solution when distilled leaves in the end nitrate at the maximum, and some silver powder, because one part of the oxyd has completed its oxydation at the expense of the other part. In this case the alcohol does not become etherised any more than it does with nitrate *major*, which it dissolves very readily.

With boiling Water.

We have seen that cold water separates the nitrate into two parts: that one part cannot be dissolved without taking some of the acid from the other part, which obliges it to separate in a yellow nitrate, or with less acid. With boiling water the changes go still farther.

If

If a few drops of solution, lightly concentrated, are dropped into a glass containing distilled boiling water, three colours will be distinctly seen to succeed each other rapidly, yellow, red, and black. If, when the mixture is yellow or red, a few drops of acid are put into it, it immediately becomes clear, and the changes cease. If it be done at the instant when the black appears, the acid does not restore the transparency; this is because the black powder is not, as the two preceding colours, an oxyd, but it is silver disoxydised. Therefore a stronger acid is necessary to dissolve this last.

The black powder silvers the glass as it falls upon its sides. None of these effects will take place, if some drops of nitric acid are added to the solution before it is poured into the boiling water.

The yellow nitrate of mercury, at the minimum, presents similar phenomena, though under different aspects. This nitrate, boiled with water in a retort, gives a mercurial powder, which passes in the recipient with the aqueous vapour; that is to say, that, by the help of an elevated temperature, one part of the mercury completes its oxydation at the expense of the other. But in all cases wherein we discover a metal passing from one state of oxydation to another, we never perceive that it stops at any intermediate term between the two extremes of oxydation, which are proper to it.

An aqueous solution of nitrate of silver, at the minimum, does not become suroxydated very rapidly by contact with the air.

I have formerly shewn that, if copper has more affinity for oxygen than silver, it must not be concluded that acids have more affinity for oxyd of copper than for oxyd of silver; and, in fact, the nitrate and the sulphate of

silver dissolved and kept upon carbonate of copper, neither attacks it, nor changes its colour; neither has the nitrate of silver, *minor* any more effect on carbonate of copper.

The yellow powder, or the nitrate at the minimum, with less acid, immediately changes, and loses its colour when in contact with the air. It becomes covered with a black powder, which is pure silver, and it is one portion of the oxyd which is disoxygenised in favour of the other.

The nitrate *minor* when concentrated in a retort thickens, produces a little nitrous gas, enters into fusion, and yields a yellow sublimate, which adheres to the sides of the retort. The nitrate *major* furnishes nothing like it. If the melted mass be dissolved, a yellow precipitate, mixed with a little silver powder, deposits, which indicates a part of nitrate *minor* which has not changed its nature, and another which has passed to the state of nitrate *major* by the oxygene which a portion of the oxyd has taken.

It is several years since I first remarked this transmission of oxygene from one part of an oxyd to the other, in solutions of silver, kept in a state of ebullition upon the metal. A kind of brilliant powder floats in it for some days, and afterwards sinks to the bottom of the vessels. This was the first fact that occasioned me to suspect that silver could be susceptible, like so many other metals, of two fixed terms of oxydation.

Nitrate of lead, treated with leaves of this metal, produces similar results. I shall endeavour to publish them soon.

Memoir

Memoir on the Decomposition of Water, and of the Bodies which it holds in Solution by the Aid of Galvanic Electricity. *By* C. J. T. DE GROTTHUS.

From the ANNALES DE CHIMIE.

With an Engraving.

CHAPTER I.

Action of Galvanic Electricity upon certain Bodies dissolved in Water.

§ 1. WITHOUT entering into the discussion of a multitude of hypotheses which have been proposed in order to explain the theory of the decomposition of water by the electromotive apparatus, I shall lay down a general theory of the decomposition of liquids by Galvanic electricity, which appears to me to reduce the effects of the latter to a simple and satisfactory explanation. I have been led to this theory by the following observations.

§ 2. When we cause to pass through a saturated metallic solution a current of Galvanic electricity, of an intensity proportionate to the space occupied by the liquid, and comprised between the extremities of the two conducting wires, we observe some phenomena which appear interesting even to those who do not take the trouble to investigate their cause. At the extremity of the wire in contact with the disk of zinc, oxygene is disengaged, whilst at the extremity of the wire in contact with the disk of copper, the molecules of the metal in solution are revifified, and assume a symmetric arrangement, extending in the direction of the Galvanic current.

§ 3. This arrangement is only an imperfect crystallisation of the metallic molecules, perfectly similar to that which is known by the name of *arborisation*, and which takes

takes place when metals in solution are precipitated by other metals. The ancients added to the name of *arbor* that of the Divinity, to whom the metal was consecrated. Hence the appellations of *arbor Dianæ*, *arbor Martis*, *arbor Veneris*, &c. Of all the phenomena which Galvanism presents to us, there is none so beautiful or so interesting as this kind of vegetation, which takes place under our eye, and presents to us the image of an elegant tree, clothed with its foliage, and adorned with its metallic lustre.

§ 4. Wollaston, an eminent English philosopher, has already found, that by establishing a current of electricity in the solution of a metal, the latter becomes revified at the extremity of the conductor, endowed with the negative electricity; but I do not know whether he has also observed that this revification is capable of assuming a symmetric arrangement, when the action is sufficientl energetic, and has continued for a certain space of time.

§ 5. Not all metals in solution are decomposed by Galvanic electricity. From the nitrate of manganese I obtained gaseous bubbles at the negative pole *, instead of a metallic disposition; and it appears, that when under the same circumstances the metal in solution has more affinity for oxygene than hydrogene has for this principle, it is the water alone that must undergo decomposition.

§ 6. During the arborisation of the metals at the negative pole no gas is seen to be disengaged at it, whence I concluded that either the hydrogene, as it was evolved,

* I shall use henceforward the term of *positive pole* to designate the extremity of the wire which communicates with the disk of zinc, and that of *negative pole* to denote the extremity in contact with the disk of copper.

combined

combined with the oxygene of the metallic oxyd, or that the action is exercised only upon this oxyd, and not upon the water. This last conclusion must be the true one; for it can hardly be admitted that the hydrogene can perfectly separate the oxygene from the oxyds of zinc and of iron, as well as from certain acids their solvents, in which these two metals have dissolved only after having produced an effect contrary to this admission, by decomposing the water.

§ 7. Of all the metallic salts which I have subjected to the action of the electromotive apparatus, the acetate of lead, and the muriate of tin *, have afforded me the finest vegetations. That of lead resembles a fern-leaf; and, upon the ramifications of the tin, I often with the magnifying glass observed octahedral crystals. It is remarkable, that the arborisation always directs itself from the negative pole towards the positive pole, whatever may be the respective positions of these poles; and that it consequently establishes itself always in the direction of the electric current. The vegetation of a metal with the aid of electricity seems in some degree to imitate that of the natural plants, which constantly direct themselves towards the light, while oxygene is evolved from them by the contact of its rays.

§ 8. When the metallic tree has extended itself till within a small distance from the positive pole, its growth is stopped, because its ramifications being in a state of extreme tenuity in every direction, annihilate the electric action, by exercising the power of an infinite number of points. It even appears that, by the two great

* I have also obtained effects more or less sensible from the nitro-muriates of gold and of platina, from the nitrates of zinc, of copper, of mercury, and of cobalt, from the sulphates of zinc and of iron, from the muriated stannite of potash, and from the muriate of iron.

approx-

approximation of the poles, each may acquire the electric power of the other; for the extremities of the metallic ramifications have sometimes begun to be oxydated, whilst a disoxydation manifested itself at the positive pole. It is probable that whenever the extremities of the two conducting wires shall be of extreme tenuity, and very close to each other in a quantity of water, the gases proceeding from its decomposition will be mixed with each other. There is here, if I mistake not, an analogy between the decomposition of the water by an electric machine, and that which is effected by the pile of Volta*.

§ 9. When the current of Galvanic electricity acts upon pure water, or upon water charged with any soluble substance, the positive pole attracts the *oxygenating*, while the negative pole attracts the *oxygenated* principle of the liquid. If the proportion of the component parts of the latter is variable, it becomes oxygenated at the extremity of the wire in communication with the disk of zinc, and disoxygenated at the extremity of the wire in contact with the disk of copper. This is proved by the following circumstances.

§ 10. The muriatic acid becomes oxygenated at the positive pole to such a degree that it acquires the power of dissolving gold coming from the extremity of the conducting wire. The sulphuric and nitric acids become transparent, and appear to be so surcharged with oxygene at the part which surrounds the same pole, that I believe them capable in this state of producing effects with which we are not yet acquainted †. At the nega-

* Wollaston, in decomposing water by the electricity of a common machine, has constantly found that the oxygene and the hydrogene were disengaged together, whereas the action of the pile determines them to ascend separately.

† At this degree of oxygenation, the sulphuric acid appears to be capable of dissolving gold: at least that which I employed for this experiment

tive pole the muriatic acid evolves a great quantity of gas *; the sulphuric acid exhales a strong sulphureous odour, and deposits sulphur; and the nitric acid is converted into nitrous acid, assuming a blue colour. If we then change the position of the two poles, so as to place each where the other was before situated, each portion of the acid passes again into its original state, and the effects commence anew.

§ 11. When a solution of muriate of tin is traversed by the Galvanic current, a white powder is gradually precipitated from it, proceeding from the positive pole. This precipitate redissolved in muriatic acid, and afterwards tried with corrosive sublimate, altered this into white, whilst the liquid which had surrounded the negative pole changed it into black. The muriate of tin had therefore become more oxygenated at the extremity of the wire, which excites the disengagement of the oxygene.

§ 12. After a long-continued action of Galvanic electricity upon the sulphate of iron in solution, this became turbid, assuming a red colour in the part which surrounded the positive pole. We ascertain that it then contains a highly-oxygenated sulphate of iron, by trying it with prussiate of potash, which immediately produces a very beautiful Prussian blue with this part of the liquid, whilst that which surrounded the negative pole gives, with the same prussiate, only a precipitate of a greenish white colour.

periment assumed a yellow colour in proportion as it dissolved the gold extremity of the wire which disengages the oxygene. When a solution of green sulphate of iron was poured into this sulphate of gold, a precipitate was formed which resembled sulphuret of gold.

* It would be interesting to examine whether this gas does not proceed in part from the decomposition of the acid.

§ 13. The molybdic acid, dissolved in concentrated sulphuric acid, assumes, when cold, a beautiful blue colour, which disappears whenever the solution is heated. When we expose it to the action of the pile of Volta, the vitreous fluid produces an effect analogous to that of caloric, whilst the resinous fluid produces one analogous to that of cold. At the positive pole the liquid gradually becomes perfectly transparent, and the molybdic acid is in part precipitated in the form of a white powder, while round the negative pole it always acquires a deeper and more dingy colour. When the position of these poles is afterwards changed, and each put in the place which the other previously occupied, the reverse is seen to happen; the transparent part again becomes blue, and the blue part becomes transparent.

§ 14. When the Galvanic current exerts its action for a long time upon the solution of an earthy salt, the base of the latter is gradually precipitated around the extremity of the wire, which has the negative electricity. These precipitates do not appear to me to be owing to a decomposition by the alkali which is *generated* at this point in infinitely small quantity; but I presume that the acid of the salt is destroyed in it, or rather decomposed, whence it results that its earthy base becomes free.

The tubes of glass which served to contain the solutions subjected to the experiments which I have just described, were often found lined with a layer of metal, which seemed to have been melted upon the vitreous matter of the interior of the tube, and which proceeded from the particles of metal detached by the action of the apparatus from the conducting wires: accordingly, when these extremities were of gold or of silver, the tubes of glass had become perfectly silvered or gilt.

TO BE CONCLUDED IN OUR NEXT.

On

On making Turf into Charcoal. By *M.* PLATEL.

With Engravings.

From the ANNALES DE CHIMIE.

IN order to compress the greatest possible quantity of turf into the smallest compass, I cause it to be subjected to an equal and continued pressure; by this means it soon loses all the water it contains, it dries freely and speedily, and much time is saved.

After this pressure has been effected, knowing that it is capable of carbonisation without this preliminary process, care is taken to expose the pieces of turf in such a way to the air as to accelerate its action among them.

In this state it is carbonised, with the assistance of an apparatus, which I shall describe.

The distilled products of vegetable substances offer advantages in this process. I conclude thence, that the oily and condensible substances ought to be detached from the gas which I would employ to sustain the combustion. This observation is so much the more valuable, since these same gases will supply the place of a fourth part of the turf or combustible matter used in the carbonising furnace; an advantage which has hitherto been overlooked.

I shall here take the liberty of mentioning some facts relative to the order in which the gas becomes disengaged during the action of the heat, applied to vegetable substances.

It is well known that calorie, when in contact with these vegetable substances, disorganises them either entirely or in part; that it requires their three principles to be combined according to their various degrees of attraction, and at various temperatures; and that the produce is very different from the original substance.

Thus, for example, those substances are disengaged first which are the most volatile, or whose principles have a greater attraction for each other at a low temperature; water, oil, and vegetable acid come over first, whether they be contained in part in the vegetable matter, or that the principles incline to a re-union by the predisposing action of the caloric; but at a high temperature, and at a red heat, the carbon decomposes the water; this latter ceases to form, and carbonic acid, with carbonated hydrogen, highly charged with carbon and oxydule of carbon, come over singly; the fixed substances remain in the distilling apparatus; and if these substances contain any azote, it is disengaged from the carbonate of ammonia at the last-mentioned point of time.

Although these phenomena occur in small pieces, heated equally in all their parts, they do not take place when there are several quintals, the exterior of which only becomes carbonised, while the centre of the mass is but slightly affected by the action of the caloric, which acts inversely as the squares of the distance.

The produce therefore of different times will be of different proportions; thus the water, the oil, and the acid, will predominate in the first essays, and will decrease in proportion, and be more carbonised at the succeeding ones.

A black, oily, and acrid substance will then appear, more or less heavy, which is the empyreumatic oil, and it is a sign that the carbonisation is approaching the desired end. In a word, the last result is a fixed substance, black, and tolerably homogeneous, weighing more than a piece of wood-charcoal of equal bulk. It often happens, in consequence of the oxyd of iron which it contains, and the compactness acquired by the previous pressure, that this substance is the real turf-charcoal, which sometimes

sometimes furnishes, before it is obtained, a certain quantity of sulphurous acid, proceeding from the combustion of the sulphur and sulphate of iron contained in the pieces of turf, such as those I have used, which in some degree justifies the fears of those persons who refuse to make use of this combustible; but this trifling obstacle may be obviated by a very simple means, which I use when burning the turf in the apartments, and which I shall relate some other time.

I shall now describe my apparatus, which I shall divide into two parts: in the first I shall describe the furnace; and in the second I shall exhibit its interior, which I call thermolampic.

The furnace is of a square form, and is terminated by an arch at the top and in the front: there are three openings in it, one above the other.

The lower part where the ash-hole is placed is formed on the inside, in the shape of a cone, so placed that its base forms the opening, one of its square faces is placed above, horizontally, and the other is an inclined plane: this form prevents the ashes from remaining to the obstruction of the heat, and renders the current of air more free. It may be easily imagined, that the upper part of the ash-hole is formed by the grate of the furnace; which grate consists of moveable bars of iron, disposed parallel to each other; by this disposition the action of the air is facilitated in promoting the combustion. Above the ash-hole is the second opening, which is that of the fire-place, which must always be kept closed with an iron door, furnished with two rings, to receive a hook to open and shut it.

The third opening is only to be perceived by the projecting part of the base of the chimney, which forces the smoke to surround the interior apparatus; and that takes

place

place effectually, since it makes its way out precisely at the level of the bottom of the thermolampe, which is supported by the inside and front of the furnace.

It is to be observed, that the upper opening of the chimney is less than the lower one, which is indispensable in this construction. This induces me to say there should exist a certain proportion between the respective openings of the fire-place, the ash-hole, the passage for the smoke in the chimney and its uppermost opening, which is always of a size proportioned to its height. Thus ash-holes of a middling depth, and open fire-places, narrow and shutting well, and an easy passage for the smoke, altogether constitute a furnace, which experience has proved to be very useful. (See Fig. 1. Plate XV.)

The second part of my apparatus, which I call thermolampic, is disposed in such a manner, that its lower part is horizontal, and forms a long square, upon which rests a kind of vault, or arch, that is flattened in the middle, terminated at the extremities by two vertical planes, in the middle of which are two pipes, bent to a right angle; these serve to carry out the distilled products to the middle of a condenser, formed either by a hollow stone, covered over with a board well luted, or by a wooden cask placed on its end, or, in a word, by a cast iron pipe crossing a running water; to these are attached pipes, which carry the inflammable gas into the fire-place, and which gas, as I have before said, serves as an additional supply to the combustible matter therein. The above pipes are furnished with a key, to intercept the communication of the external air with the charcoal while yet warm; for experience has proved that charcoal, when just prepared, will sometimes inflame spontaneously. It has been said that this phenomenon sometimes occurs in large quantities of charcoal that have been made

Fig. 4.

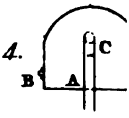


Fig. 2.

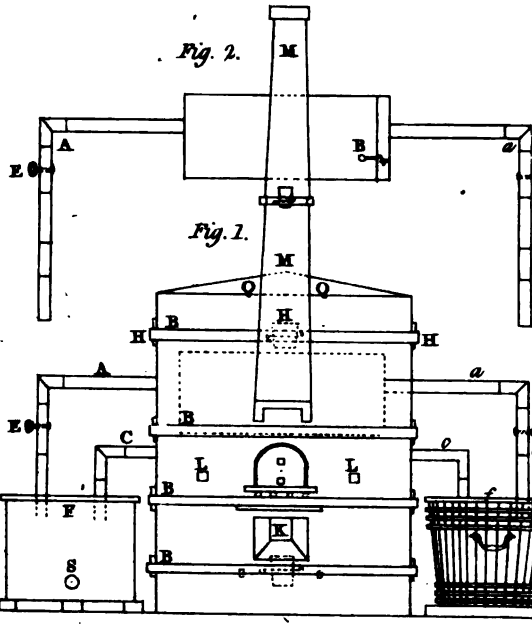
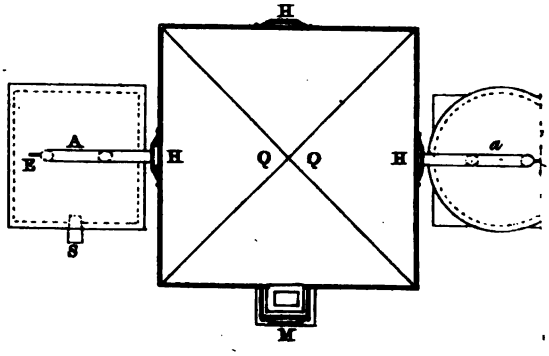


Fig. 3.



made a long time, but I confess that I never saw it happen: nevertheless, it is as well to be prepared to prevent it, by conducting the currents of fresh air that cross the mass in various directions. (See Fig. 4.)

The material which composes the thermolampic apparatus is iron forged, or cast very thin; but one or several common cylinders, conveniently placed, may be used in its stead, and furnished at their extremities with two tubes, to disengage the gaseous products, &c.; care being taken that one extremity shall open and shut by means of a hook and eye.

The part of the furnace by which the substances intended for carbonisation are introduced, ought to be formed of dry brick, and covered over with tempered clay.

Thus, whatever the form and material of the thermolampe may be, it should always be placed horizontally in the furnace, and have its extremities placed or supported on the lateral brick-work: in this situation the bottom and all the parts about it experience the action of the fire, which is (as I have already said) fed by the bad turf, and assisted by the lateral pipes.

To all this must be added a strong bar of iron, which is designed to keep the apparatus firm when filled, and while receiving a long continuation of the heat.

I have used very advantageously a part of the heat proceeding from the smoke while yet warm, by the construction of a kind of stove, which serves to conduct the turf into the carbonising apparatus.

It is easy to imagine which are the most convenient methods of promoting this desiccation, especially in winter.

TO BE CONCLUDED IN OUR NEXT.

List

List of Patents for Inventions, &c.

(Continued from Page 320.)

THOMAS PEARSON, of Haberdashers' Place, in the parish of Saint Leonard Shoreditch, in the county of Middlesex, Wholesale Upholsterer; for a machine or machinery for the purpose of cleansing, seasoning, and dressing feathers and other articles. Dated Aug. 30, 1806.

JOHN CAREY, Dr. of Laws, of Camden-street, Islington, in the county of Middlesex; for various contrivances for preventing or checking fires, and preserving persons and property therefrom, by means of divers improvements in alarms, chimnies, cisterns, fire skreens, and other articles. Dated Aug. 30, 1806.

CHRISTOPHER WILSON, of Windmill-street, Tottenham Court Road, Middlesex, Master Mariner; for a new system of naval architecture. Dated Aug. 30, 1806.

ROBERT NEWMAN, of Dartmouth, in the county of Devon, Ship-builder; for improvements in the form, formation, and construction, of ships and other vessels of war, and ships and other vessels of commerce, and of sloops, barges, and other vessels, any otherwise employed. Dated September 6, 1806.

JOSEPH MANTON, of Davies-street, Berkeley-square, London, Gun-maker; for improvements in double-barrelled guns. Dated September 15, 1806.

ISAIAH BIRT, of Plymouth Dock, in the county of Devon, Gentleman; for a black paint, composed chiefly of earthy and mineral substances, which will be beneficial to our navy, and the shipping-interest at large; being particularly calculated to preserve wood, and prevent rust in iron, and may be applied to all purposes for which paint in general is used. Dated September 18, 1806.

MARC ISAMBARD BRUNEL, of Portsea, in the county of Southampton, Gentleman; for a new mode of cutting veneers, or thin boards. Dated September 23, 1806.

THE

REPERTORY

OF

ARTS, MANUFACTURES,

AND

AGRICULTURE.

No. LIV. SECOND SERIES. Nov. 1806.

Specification of the Patent granted to RICHARD WILLCOX, *of the Parish of St. Mary, Lambeth, in the County of Surrey, Machinist; for certain Machinery for glazing and graining Leather, now usually performed by Hand.*

Dated March 8, 1806.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said Richard Willcox do hereby declare that my improvement or invention for glazing and graining of leather, and glazing and imbossing leather, is as follows; *viz.*

First. By so disposing or placing a number or series of small rollers, forming a circle round a large roller, cylinder, drum, or shaft, which are placed in such a manner, that only one, two, or three, of the said rollers shall be on the skin at one time, whereby a pressure commensurate to finish the glazing and graining the leather superior to hand is effected without breaking, tearing, or injuring the skin.

Secondly. I do hereby farther declare, that I arrange and place the said small rollers (as hereinafter described) so that at every rotation of the larger roller, drum, or cylinder the small rollers commence their operations in or on the middle part of the skin, and work outwards from the centre of the skin to its edges; which having a tendency to smooth the skin whilst working from the centre outwards, it is prevented from being creased, which otherwise would injure the leather.

Thirdly. Farthermore I declare, that I place three, five, six, or more rollers, (according to the sizes of the skins to be finished,) turned true, but made of the end grain of the wood, turning outwards from the centre of the skin towards each edge or side of the skin; for instance, when I use six rollers, three of them turn outwards to the right, and the other three rollers in a contrary direction to the left; which said rollers are placed in a frame, or other convenient apparatus, and are driven or turned by a shaft, band, chain, or other simple and well-known ways for driving machinery. The said rollers are also placed close, as is convenient, to the small rollers that glaze and grain as before described, for the purpose of stretching, holding, smoothing, or keeping steady and smooth, the skin previous to its passing under the rollers that glaze and grain the leather.

Fourthly. I do farthermore declare, that I produce the same grain, or make a similar impression on skins, as is now produced by muscular power, but more accurately, in the following simple and novel manner. First, I place a skin, in a seasoned or damp state, between the rollers as described (which in this case are turned smooth), and after glazing the skin without any grain or impression whatever, I place the glazed part of the skin in contact with a copper plate, or other plate, made of a composition

tion of metals, such as is used for printing, and which is previously engraved or etched so as to produce an impression similar to that wrought on the skins by hand, or any other device, ornament, or embellishment; and then pass the skin and plate between a pair of rollers similar to those used for copper plate printing, and next finish the skin by passing through or under the glazing rollers, as at first, which complete the gloss or polish; or, in other cases, where leather is to be used for hatters, bookbinders, or for covering furniture, &c. instead of passing it through or under the rollers for glazing it after the impression is given by the plate, I use elastic varnish to finish the skin, whereby the most beautiful impression and polish is given to the leather. Also a farther advantage is derived from the above improvement; namely, that of impressing landscapes, flowers, or any other ornament on the skin, at the option of the manufacturer, which cannot be performed in the usual way of glazing and graining skins by muscular power.

The following is a more particular description of the drum and graining and glazing rollers, and the manner of placing them, to which I have alluded in the first and second head. First, I place, in a simple convenient framing, which every millwright or mechanic may construct, according to the situation of the premises and the scale of business intended to be performed (therefore it is unnecessary for me to describe it, because it forms no part of my patent), an iron cylindrical roller, or wooden roller, or stout shaft, working on a bearing on each end of the said framing, with a wheel or rigger attached to the shaft for turning the said roller. The most convenient size for the said roller I find is about four feet six inches long and one foot diameter, which is to be divided longitudinally into fifty equal parts or divisions, and likewise divided into fifty parts in circumference; when I place the

small roller for graining and glazing the leather, which in this case I use, about two and a half inches diameter and one inch three quarters thick or deep, fixed into a spring about ten inches long, and equal to carry two hundred weight, bent so as to form a portion of a circle of about fourteen inches diameter; which said springs and glazing rollers I fix or place on the aforesaid iron roller or cylinder, divided as above described. The first spring I fix on the centre line or division, marked or drawn on the iron roller, whilst the second spring is fixed on the third line, and the third spring is fixed on the fifth line, drawn longitudinally on the iron roller, thus missing every other line on each side of the first spring fixed to the lines drawn longitudinally on the iron roller; but, on the contrary, each roller is to be placed or fixed to each and every line successively drawn round the circumference of the said iron roller or cylinder, whereby it will be found, when the first sets or series of rollers are fixed to the iron roller or cylinder, that the roller or cylinder will be covered longitudinally, and but half way in circumference. I then place or fix the second series of rollers, beginning on the second longitudinal line missed by the first series of rollers, and so on successively, but in a direct line where the first series of rollers terminated; so that as soon as the first series of rollers when turned shall have passed the skin, the second series of rollers shall then commence. Thus, as the rollers are nearly twice the width of the spaces marked on the iron roller or cylinder, and cross or work in each other's wake or track, they lap or cover each other during every revolution about three quarters of an inch, whereby the whole of the skin is completely grained and glazed; and, in order to adjust or bring the said small rollers for graining and glazing into a regular line, so that they may press on the bed, which may be either a roller or smooth surface on which

the

the skin is held, and shifted or moved forward whilst glazing by the said small rollers, I place an adjusting screw, tapped or screwed into the springs for holding the small glazing rollers, which springs are previously described above, one-third of an inch from that part of the spring which is fixed on the iron roller or cylinder; and as the end of the adjusting screw comes in contact with the iron cylinder, the said springs and small rollers attached thereto are readily and speedily adjusted. The said small rollers are grooved or fluted, and the skin is prepared or seasoned, and worked by the machine in a similar manner to those skins worked by the hand, (except as in the fourth case,) and the rollers are turned and the skin moved forward by any of the simple and well-known methods of driving rollers for machinery.

Lastly. I do hereby farthermore declare, that the best speed that I have found in practice is, that the skin should be moved forward about three-eighths of an inch every revolution the glazing rollers make. And that, although I have particularly given the dimensions of the drum or iron cylinder, and glazing and graining rollers, as I have found most convenient in practice, nevertheless I do not confine myself to such proportions; for the drum may be increased or decreased in diameter, and a greater number or larger rollers placed thereon, or *vice versâ*, the effects to be produced being simply fourfold: first, that not more than two or three graining and glazing rollers be on the skin at one time; secondly, that they tend to smooth the skin; thirdly, that the second tier or series of rollers cover the spaces left by the first; and, fourthly, that the rollers follow each other in succession so close as not to come upon the skin suddenly or with a blow, but to glide or slide easily on the skin. All of which properties are combined in the said machine, and which constitutes my improvements, In witness whereof, &c.

Specification

Specification of the Patent granted to HENRY MAUDSLAY, *of Margaret-street, Cavendish-square, in the County of Middlesex, Mechanist; for a Press, upon an improved Construction, for printing Calicoes and various other Articles.* Dated July 29, 1805.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Henry Maudslay do declare that my said invention is described and ascertained in and by the above drawings, and description thereof.

In witness whereof, &c.

DESCRIPTION of the DRAWINGS.

Figs. 1 and 2 (Plate XVI.) represent an end and front view of the machine. A A are frames of cast-iron, wood, or other strong materials. B B are swinging frames of iron or wood; the upper surfaces of which are made flat, to receive engraved copper plates, fastened on and regulated by screws at *a a*. The screws at *b b* are to stop and regulate the swinging frames against pieces which project on the insides of the frames A A at *d d*. C are slings or connecting rods of iron or other metal which have round holes at D in the bottom end, to receive the ends of the strong bolt D, (which is connected to the frame B B). The upper part of the connecting rods C are forked, to pass the pivots of wheels, &c. on the ends of the frames A A, and are screwed in the usual way, have two metal nuts to each, to keep down and regulate the cross pieces of iron or other metal *e*, which fit on and into the eccentric wheels or cranks E, (which are made of iron or other metal,) for the purpose of lifting the swinging

swinging frame B by means of the connecting rods C C, and pressing the copper plates forcibly against the under part of the cylinder or press head F, which is better seen in Figs. 3 or 5. Through the eccentric wheels, &c. are made square or other formed holes, which are well fitted on the spindle G, close on the outsides or insides of the frames A A; on the outsides of which are fitted the toothed wheel H, which works into and turns the wheel I, which is twice the diameter of H, and has on the rim a piece of metal of the proper curve with three whole teeth and one half tooth, which in their revolution fall into the teeth of the wheel K, fixed on the axis of the roller L; which wheel will be regulatd as to its number of teeth by the circumference of the roller L, which must be twice or three times the length of the engravings on the plate to be printed from; if twice, it must have eight teeth; if three times, twelve teeth; or in that proportion. The half of every fourth tooth must be taken away to let the tooth or the segment on I pass, that it may strike fairly on the pitch line of the next tooth. The small roller M may be used or not, as occasion may require, as it is only to ease the motion of the blanket which passes over the roller N, which is to tighten the blanket by means of the screws and sockets O. At the opposite end of the spindle G is well fitted a large wheel P, which is turned by the pinion Q on the spindle of the fly-wheel R, and supported by the frame S (of iron or wood). This spindle may be turned by hand, or any other given power. The wheel and pinion may be varied to any power, by altering the sizes of them in the usual way. The plates may be cleaned in the usual way, by a scraper or doctor.

Fig. 3 is a transverse section of the machine, shewing a different mode of using it. The frame A A is the same

same as in Figs. 1 and 2, with the addition of two arms and brackets TT, which support a frame of iron or wood, on which are fixed one, two, or more copper plates. To print several colours they move to stops, and are regulated as in Figs. 1 and 2. The cylinder E is made hollow, for the purpose of admitting steam, which will heat it to any temperature, to dry the colour as quick as printed. The manner of letting in the steam is described in Fig. 5. The lifting-frame B acts the same as in Figs. 1 and 2.

Fig. 4 is a lifting-frame, which has a cylinder similar to F, and may be used in the place of B, which makes it a hot-press for various purposes, by letting steam into the bottom as well as the top cylinder; and in case the colour should dry in the plates owing to the heat, cold water may be made to pass through the cylinder, which will always keep it cool.

Fig. 5 is a longitudinal section of the cylinder, eccentric wheel, &c. with the manner of admitting steam by a small pipe at *f*, which may be communicated with the boiler of a steam-engine, or a small boiler on purpose, which will serve one, two, or more presses, each having stop-cocks at convenient places. *g* is a pipe in the bottom of the cylinder, to let out the condensed water.

Figs. 6 and 7 represent a side-view of the upper part of the machine, with the roller L placed above the cylinder, by which means the blanket is closer, and may if required receive more heat from the cylinder. The roller is moved by the same wheels as in Figs. 1 and 2, only differently placed.

Specification

Fig. 3.

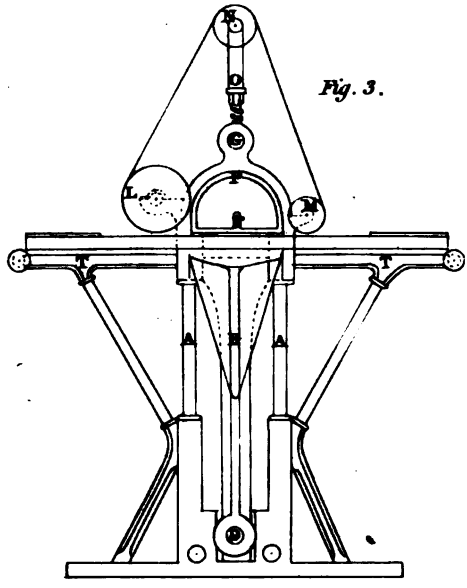
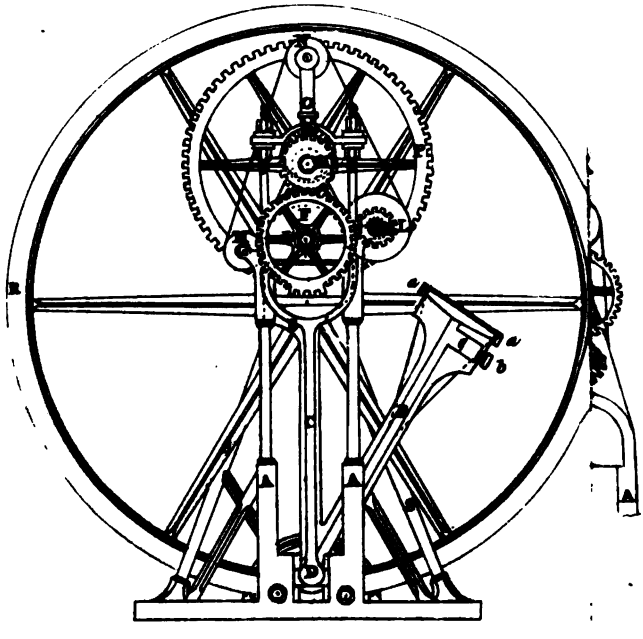


Fig. 1.



Specification of the Patent granted to ROBERT WALE KING, *of Kirby-street, in the Parish of Saint Andrew, Holborn, in the County of Middlesex, Tin-plate-worker; for a Method of manufacturing Tin, or Iron Plates covered with Tin, commonly called Tin Plates, into Covers for Dishes and Plates.* Dated May 8, 1806.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I Robert Wale King do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed; and I have for that purpose made and prepared the drawings hereunto annexed; in which Fig. 1 (Plate XVII.) represents the sides or body of a cover, which are of entire pieces, and made of tin, or iron plates covered with tin, commonly called tin plates, and are hollowed, and planished and grooved together, either inside or outside, from E to F, in the manner heretofore practised for making dish-covers; the sides or body is left of sufficient depth from F to the bottom of the cover for the making my new and improved mouldings at the foot or base thereof, instead of adding a rim to the same by the method now practised. I regulate this depth according to the particular moulding I propose to put on the cover. I put the sides or body of the cover together, and solder the grooves thereof from E to F, while the top is yet off. I then lay the sides or body on a piece of lead or block, having a hollow place or hollow sunk in it, and with a bouge-hammer I sink a hollow or bouge on the side or body of the cover, immediately below F, as represented by A, Fig. 2, and which is either higher or lower according to the form or depth

of the moulding I intend to make. This hollow or bouge may also be produced by a swage or tool the shape of the bouge; but I prefer the hammer and lead or block, being less liable to injure the stuff or metal plates: the bouge being made in the sides or body of the cover. I then place it between the swage or tool Fig. 3, to form a moulding according to the pattern desired, as represented by B, Fig. 3.

Fig. 4 represents the sides or body of the cover under the swage or tool Fig. 3, which in the operation is moved round by the workman on the bed or bottom of the swage or tool G, Fig. 3, the form of which is represented by the dotted line. The edge of the sides or body of the cover being pressed by the workman close to the guide H, Fig. 3, the impression is given by smart strokes of the hammer C, Fig. 3, as represented at D, Fig. 4. When the cover is finished swaging I solder the sides or body from F, Fig. 1, to the bottom, and then wire it round, and groove the top in the ordinary way.

Fig. 5 represents a cover finished. I make these covers for dishes or plates either oval, round, or oblong; in the making of which, the operations, as I have already stated, are the same.

Fig. 6 represents the swage or tool, which is made of iron or other hard metal; A, being the hammer, having its face cut according to the moulding proposed to be made on the covers. B is the bed or bottom of the tool or swage, having its face cut responsive to the indention on the hammer. C is the pivot or joint on which the hammer works. D is a ferrel guide, by which the width or depth of the moulding is regulated, and is moved backward or forward at the will of the workman, and fixed to the intended place by means of the nut or screw. E F is the shank of the swage or tool, which

Fig. 7.

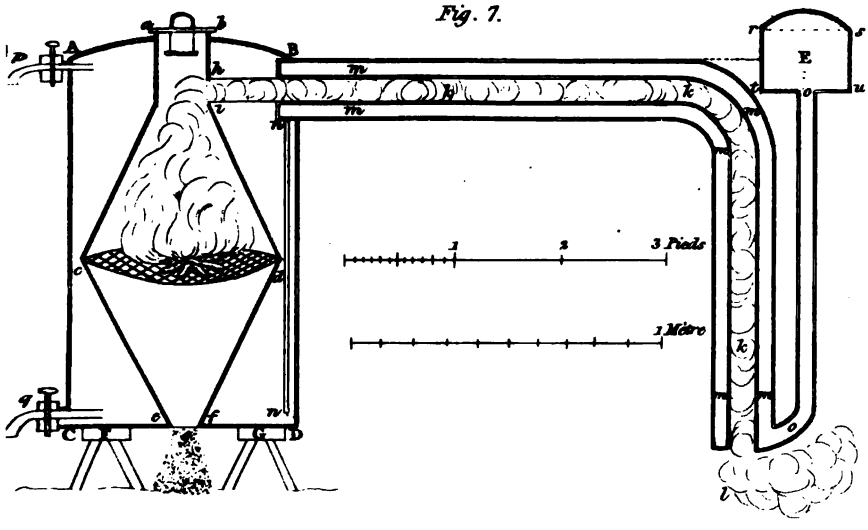


Fig. 1.

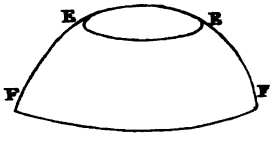


Fig. 2.

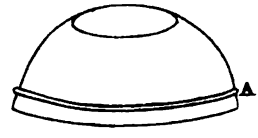


Fig. 5.

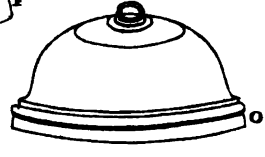


Fig. 3.

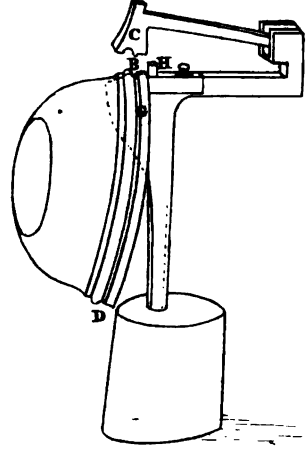


Fig. 6.

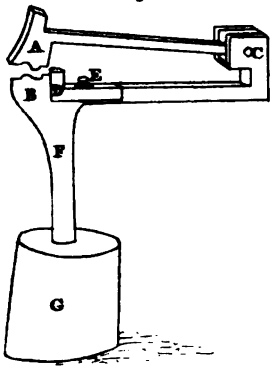


Fig. 4.

which is also made of iron or other hard metal, and is of length sufficient to raise the sides or body of the cover from the block or bench G on which the swage or tool is fixed.

In witness whereof, &c.

Specification of the Patent granted to WILLIAM DEVERELL, *of Charles-street, Blackfriars Road, in the Parish of Christ Church, and County of Surrey, Engineer; for certain Improvements in the Mode of giving Motion to Hammers, Stampers, Knives, Sheers, and other Things, without the Application of Wheel, Pinion, or any rotative Motion, by Means of various Powers now in common Use.* Dated June 6, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Deverell do make known and describe my said methods of giving motion to the aforesaid things, and how the same is to be performed, as follows; that is to say: First, I raise steam in a boiler or steam vessel, as in the common way. I have a steam cylinder with a piston and rod in it; at the end of the rod that comes out of the steam cylinder is a hammer, either made fast to the rod by welding or any other common way. The steam from the boiler or steam-vessel is let in underneath the piston by means of opening a cock or valve, or cocks or valves; the air at the top of the piston will be then compressed by means of the superior pressure of the steam underneath the piston. After the piston has been raised to a given height, there will be an opening made in the underside of the piston to a vacuum formed as in the common way, or otherwise the steam may be let

out into the common air. The compressed air on the top of the piston will then drive down the hammer with a velocity equal to what it may be compressed. There may be a vessel partly full of water, the top of which is made to communicate with the cylinder. At the upper side of the piston there should be valves or cocks, or some other proper contrivance, to adjust the water, so as the air may be compressed as the velocity of the hammer may require. The hammer may be worked by steam, or some other spring that may answer the intended purpose, or by steam alone. The weight of the hammer may be made equal to the pressure of the steam, so as to work without springs. The weight of the hammer may be regulated as necessity requires, by taking one hammer off, and putting on another of a different size; the hammer may have a stilt to it, and the piston may be made fast to the hammer or stilt, as occasion may require, or otherwise there may be a lever or levers; either of these may be attached to the piston-rod so as to give motion to the hammer or hammers, as more may be worked than one in this way. There may be hammers worked from both ends of the cylinder as the piston rod or ends may come out at each end of the cylinder; and the air may be compressed in the cylinder or any other convenient vessel or vessels. The hammer or hammers may have motion given to them by the piston-rod, without being connected one with the other, by striking on the back part of the hammer-stilt; or otherwise, by lifting underneath the stilt at the hammer-end of the same: but this may be done in various other ways, not necessary here to be described.

The stampers may be worked in the same manner as the hammers: the method I make use of to work presses is as follows. I have a lever, or compound levers, with one

one end of the lever or levers working on a fulcrum or joint, with the piston-rod attached to one end of the same lever or levers; and as the steam is let on the piston from the steam-boiler, it will lift or compress the lever or levers as may be required. The lever or levers may be fixed so as to work perpendicularly, horizontally, or in any other required direction. The shape, size, or form of the press may be varied, agreeable to existing circumstances. The knives may be made fast to the piston-rod, or any convenient thing connected with the piston-rod; or otherwise the piston-rod may be made fast to the lever or levers, or knife or knives, or other levers may be used if found necessary so as to work the knives; but those knives may be fixed in various other ways, so as to chip fustick, logwood, and other woods; and may also be fixed to any proper thing which will work to and again by the piston-rod being attached to some part thereof. The shears may be worked by the piston-rod being attached to the end of the shears-lever; or there may be a second lever, or more if required, so that the piston-rod may be attached to some convenient part thereof, in order to give motion to the shears.

I also apply the above mode for the working or giving motion to bellows. In that case the piston-rod may be attached or made fast to the back part of the bellows, or separate levers may be made use of, which may be made fast to any part of the bellows.

In the above I have given a plain and clear description of the nature of my invention, and what I conceive will be fully sufficient to enable any intelligent workman to carry the same into complete effect.

In witness whereof, &c.

On invariable Pendulums. By Mr. J. W. Boswell.

Communicated by him in a Letter to the Editors.

Gentlemen,

Some remarks on a paper of mine, of a remote date, having been published by Mr. Nicholson in his Journal of last month, I have to request the favour of your permitting me to reply to them in your very useful work.

I had asserted in my paper, that the alteration of the dimensions of bodies from change of temperature depended in a great degree on the bulk of those bodies: those of larger size altering less in this respect than the smaller.

To this it has been objected, that it is possible bodies may expand partially; an instance is given of iron heated red hot in one part doing so; whence it is inferred, that the same circumstance takes place in *all bodies* at *all temperatures.*

The possibility of partial expansion in certain cases is well known, but its universality is by no means evident; and there is great reason to think that at low temperatures (especially when their changes are as gradual as those of the atmosphere) the tendency to partial expansion in bodies is so corrected by the cohesion of their parts as not to occasion any perceptible change. Certainly, if the large masses of stone which I mentioned were heated red hot in any one part, not only partial expansion would take place, but the destruction of some part of the stone also, and perhaps the cracking of the whole. And the author of the remarks might as well assert

assert that the latter effects *always* take place at low temperatures as the former.

One of the greatest impediments to knowledge is the rage of generalizing; but Nature is not to be forced by our opinions: we find that its operations are modified by every concomitant circumstance, and that time, place, size, and degree of temperature, according to their variations, produce various effects. On a natural fact opinion is nothing; if it were of any signification; there can at least be no great weight attached to that of a person who chuses to conceal his name, and thus (according to one meaning of the old adage, *si non vis intelligi debes negligi*) voluntarily relinquishes all personal consideration.

What I have stated on the subject is farther corroborated by Mr. Pine and Mr. Crosthwaite's pendulums having performed with uncommon accuracy, which were fitted up so as to depend on large masses for their change of dimension; the reverse of which would have taken place had the opinions of the author of the remarks been founded in fact. The performance of these pendulums may be fairly considered as experiments in favour of my position, and are experiments no less accurate than decisive.

My antagonist has given his opinion, that the partial expansion in timber by heat of the air is so great as to twist screws from their first position, so as to produce a new source of inaccuracy in pendulums, by raising the socks which were supported by them.

If this position were true in the degree he infers, all frame-work held by screws or nails, and particularly metal work, must soon come asunder from the breaking or twisting of the connecting parts; at least some sign would be exhibited of this unequal movement of the body by evident marks of bending on the screws or nails; but nothing

nothing of the kind having been ever noticed, shews the opinion to be fallacious. And had this cause of error subsisted, Mr. Pine's pendulum, the cocks of which were sustained by screws, must have performed worse than a common one, which is contrary to the fact.

Besides, if this partial expansion in bodies took place to that degree above mentioned, the surface of all large blocks of every kind of stone, and every other friable substance, would crack by degrees and fall off, and the whole at last crumble away; but we know that granite, and a variety of other stones, (not affected by the damp or chemical action of the atmosphere,) retain the same surface for ages.

But even granting that the tendency to partial expansion should not be corrected by adhesion, its effect on the large blocks, recommended in my paper for the support of clocks, could be very easily prevented, by inserting strong metallic supports for the clock and the compensation bar a considerable distance into the blocks, and leaving a groove of an inch or two deep, or more if required, and a quarter of an inch broad, all round the front of the supports between them and the block; which groove should be filled tight with wool or any other elastic non-conductor of heat after the supports were firmly fixed in their places, and by this means the apparatus would be entirely sustained by the internal part of the block, and not affected by the movement of the external part from partial expansion. And, on this view of the matter, it is evident that this partial expansion, if it exists, will be rather favourable to the use of the large blocks than otherwise; for, in proportion as the expansion and contraction is confined to the external part of the block, its internal part must remain unaltered in its dimensions.

I therefore

I therefore do not oppose the supposition of the partial expansion of large blocks at the ordinary temperature of the atmosphere, as at all injurious to my former statements, but because I think it does not actually take place to any perceptible extent.

What was mentioned in my paper relative to pyrometers has indeed been objected to, but still remains uncontroverted, contrary to my antagonist's assertion. In all the instances mentioned of pyrometers said to be without the defect I noticed in the notes on this subject, the writer's own words betray its actual existence. Of Deluc's pyrometer he thus expresses himself in the conclusion: "And the plank which supported it *would* remain at the same temperature during the experiments, or *might be kept* so by means similar to those mentioned by Mr. B. or his block of stone itself might be used." Here then the deficiency of this apparatus is clearly shewn. The necessity that the plank should be kept artificially at the same temperature proves that its change of temperature would be a source of error. If the experiment were of very short continuance, perhaps the temperature of the plank might remain the same; but in long experiments, necessary to prove the adequacy of compensation pendulums, the temperature of the plank would evidently alter, from the changes of the surrounding medium.

Ramsden's being obliged to surround the bar with ice which supported the arms of his pyrometer, evinces the same defect to exist in his pyrometer.

An expression relative to Magellan's instrument proves also that it was not free from the same objection. The expression is as follows: "consequently no error could arise *but* from expansion in the plank;" which allows that the expansion of the plank would be a source of error.

My assertion therefore on this subject still remains in force; which was to this effect: "that pyrometers, as hitherto made, exhibited the sum of alteration of dimension of their own parts in conjunction with those of the substance to be examined, instead of that of the latter solely; and that it would be difficult to apply heat to the substance under examination artificially without altering the dimensions of the pyrometer itself; to which I may now add, that it would be no less difficult to apply artificial heat or cold to the pyrometer (to prevent the change of dimension of its parts during experiment) without its affecting the dimensions of the substance under examination.

The objection to what I mentioned relative to the mixed metals of the gridiron pendulum, like some of the other objections, rather corroborates my assertion: the necessity of the allowance for adjustment mentioned in it, proves the very existence of the defect, and shews the trial proposed, of simple metals for the same purpose, to be worthy of some attention.

The use of filling the tubes with substances known to be bad conductors of heat, such as those I mentioned, and of covering them with the same, which my antagonist affects to be ignorant of, is obviously to prevent change of temperature at their external and internal surfaces. After Rumford and others have published so much about non-conductors of heat, not to know their use is not very creditable to writers on those subjects.

I have now only to reply to the assertion, that my remarks relative to an anonymous publication against the pendulums before mentioned of Mr. Pine and Mr. Crosthwaite were unjust and harsh. The author of that paper had made some national reflections against Mr. Crosthwaite, and my observation related solely to this circumstance,

cumstance, stating merely the illiberality of such reflections, and that his mistakes deserved an appellation of the same stamp as that he had bestowed on those of Mr. Crosthwaite.

To enlarge on the illiberality and impropriety of national reflections, either in conversation or in print, on any subject, but particularly on those relating to philosophy, I hope is not necessary to the gentlemen who read this work: the term *harshness* is indeed abundantly applicable to those who make national reflections, but not in the least to those who merely point out their impropriety. And if national reflections are so obviously illiberal, the appellation is evidently not unjust.

Yours, &c.

J. W. BOSWELL.

Improvement in Canal Locks.

By Mr. ROBERT SALMON, *of Woburn.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Ten Guineas were presented by the Society to Mr. SALMON.

FOR the inspection of the Society of Arts, &c. I have forwarded my model, and you herewith receive enclosed a description thereof. The novelty of this mode of bringing into action a considerable force will, I hope, appear; and I beg leave to observe, that besides the principle being applicable to locks, it will apply to many other uses where a lift or descent is required. It may also be right to observe, that the curve may be so constructed as

to counteract the inclination of the load on the plane, under any irregular operation; and being so constructed, the load will in all cases be nearly as easily moved as if always running on a level surface.

In Plate XVIII. C is supposed to represent a canal lock of the common construction, whose lower gates *i i* open towards or into the lock, and its upper gates *k k* open towards the upper or higher level of the canal; D is a hollow caisson, or water-tight chest, which is fitted to a walled chamber or side-lock, so as to move freely up and down therein; *i* is an opening, which forms a connection between the lock and the caisson-chamber, and which can be closed by a shuttle fitted thereto, when required. Four standards, *e e e e*, are firmly fixed on the ground and walls of the lock and chamber; and four posts, *c c c c*, are fixed in the four corners of the caisson; on each alternate pair of these standards and posts the frames *a* and *b* rest, as on so many fulcrums, or moveable joints; the frame *b* (Figs. 1 and 2) has two straight parallel bars of thin iron fixed thereto, and standing up above the same; the frame *a* has two similar bars affixed to it, except that the top edges of these are hollowed into a curve, as shewn in the figures. B A is a carriage loaded with two heavy leaden weights, and resting on four low brass wheels, having grooves in their circumferences like sash-pullies, to receive the iron bars upon the frames *b* and *a*, so that the carriage can be drawn along upon them; the distance of the axles of their wheels is such, that when the wheels at B rest on the frame over two of the posts *c c*, the wheels at A shall at the same time rest over the other two posts *c c*, as shewn in Fig. 1; and when the wheels at B rest over two of the standards *e e*, the wheels at A shall at the same time rest over the other two stand *e e*, in Fig. 2. In order to work

work the model, the carriage must be brought into the position shewn in Fig. 1, and this can readily be done by stops, which are provided in the proper places on the curved bars, for preventing the wheels from rolling too far; as much water must then be poured into the lock C, as will fill it exactly to the black line *d d* withinside the same; and if the table on which the model stands be not level, small wedges or chips must be put under the model where necessary, until the surface of the water exactly corresponds, all round the lock, with the top water-mark or line above mentioned; it must likewise be observed, to place the model across the table, so that the weight *h*, when hung over the pulley *f* or *g*, may be at liberty to descend. Then hang the two-pound weight *h*, Fig. 1, by the line over the pulley *f*, at the upper end of the lock; and the carriage, or load B A, will be drawn forwards into the position shewn at Fig. 2, and the water in the lock C will pass through the shuttle, to buoy up the caisson D, and its surface in the lock will descend to the lower level. Again, by shifting the weight to the lower end *g*, the load will again be brought back, the caisson depressed, and the water forced through the shuttle, again raised to the higher level *d d* in the lock, as in Fig. 1.

Hence it is evident that the water in the lock, with or without a boat therein, may be raised or lowered, by the application of any force to move the carriage or load, horizontally on wheels. That when it is intended to pass a boat from the upper to the lower canal, the water in the lock is raised to the top water-level *d d*; the upper gates *k k* are then readily opened, and the boat floated into the lock; this done, and these gates shut, the water and boat, by withdrawing the load from the caisson, is lowered to the lower level of the canal. The lower gates

i i are then opened, and the boat floated from the lock to the lower canal. In this operation of lowering a boat, it is evident, that so far from there being a waste of water, a weight of water equal to the boat and its load is raised from the lower to the upper canal; for when the boat at the upper level first enters the lock, its own weight of water is displaced, and forced into the upper canal. And again, when it is floated into the lower canal, as much is again from that canal displaced, and forced into the lock.

On the same principle that water is gained by a descending boat, as above described, it will be observed, that no waste ensues in an alternate passage; and that in an ascending passage a loss of water equal to the boat and its load only takes place.

It should be understood, that as canals are sometimes more or less full of water, locks on this principle must be constructed to raise and depress, to the greatest extremes that ever happen, from the highest high-water to the lowest low-water mark, and that being so constructed they will apply to any intermediate heights; the curved plane *a* being formed, to adjust and counter-balance the inclination of the wheels on the other plane *b*, thereby maintaining an equilibrium, at any intermediate height, which the water in the canal may happen to be at.

Having described its manner of operating, I shall explain and compare cause and effect; for which purpose it may be requisite first to state, that the load of the carriage B A is fifty-six pounds, which weight, when advanced, presses directly over the parts *c c c c*, with all its gravity bearing on the caisson; but when the load is drawn forwards it rests entirely on the fixed standards *e e e e*, and by this change the whole effect is produced.

Now,

Now, if the model be set properly to work, it will be found that a two-pound weight, suspended over the pulley at either end, will put the carriage in motion, and thereby raise or depress the water in the lock; and that to do so, the two-pound weight will descend sixteen inches. Hence, two pounds descending sixteen inches, may be denoted the cause or power to produce the effect. Farther, it follows, that this two-pound weight descending sixteen inches produces the same operation as fifty-six pounds laid in the caisson would perform, and this sinking of the caisson D may be denoted the direct effect produced by the two-pound weight. The indirect and requisite effect being that of depressing or elevating the water in the lock C, and the comparison thereon will stand thus: the surface of a body of water, of an area of twenty-four inches by ten, is raised about four inches and a half by the power of two pounds descending sixteen inches; and *vice versâ*, by reversing the power, the water is again depressed.

The shuttle *i*, between the lock and the caisson chamber, will regulate the time of the ascent or descent of the caisson.

In reading over the copy of the paper which I hastily drew up, and sent with my model, I observe that I omitted making any remarks on its applicability, improvements to be made in the carriage to facilitate the moving of the load, and on the different other ways, besides the one shewn in the model, by which it may be put in action.

It will readily occur to every engineer, that this sort of lock is not confined to the particular shape of the model, or to any particular form. The caisson chamber may be placed endwise to the lock; may be of any shape,

shape, and placed at a nearer or farther distance, as may be required.

On comparing the length and movements of the frames in the model, with what may be required in practice, it will appear that the length of timbers at large will not be such but that strength sufficient may be obtained for any load. It is also evident, that although the frames consist of only two bearers in the model, yet, at large, any number may be introduced parallel with each other, and as many wheels as bearers.

In this operation the weight of the carriage itself contributes towards the effect, which in common cases is otherwise, as generally there is an objection to the great weight required to make a carriage sufficiently strong for any extraordinary purposes; and there is no doubt but, by an improvement of the carriage, it may be made to require much less than the power used in the present model. The mode I should pursue would be, to make the load in the wheels themselves; that is to say, the necessary load to produce the effect should be two solid iron cylinders, running on as many bearers as are requisite, and to have a frame or carriage for the purpose only of connecting the cylinders; by these means the strength and friction of the axle-trees would be reduced very much, and the means required then to perform the operation would be only to put the body in motion, and to overcome any little obstacle or irregularity, that the peripheries of the cylinders would meet with in their progress.

The advantage of rollers over wheels has been admitted, even where the peripheries of the cylinders were in contact with the incumbent weight resting on the top of them, as well as with the supporting plane below; but in the case above suggested they have more advantage,

Fig. 1.

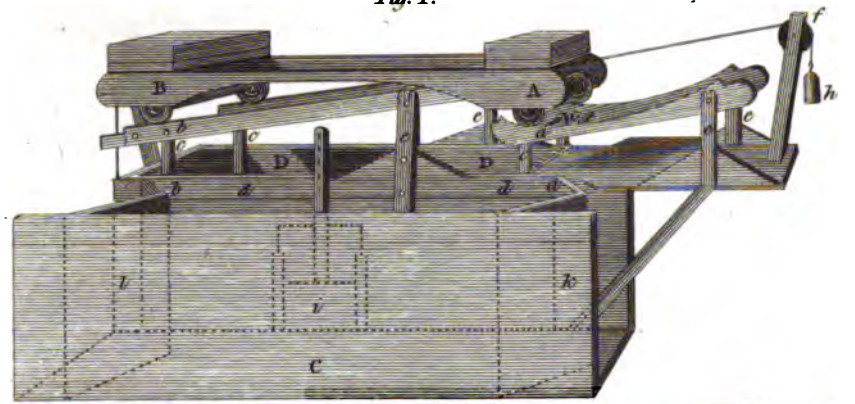


Fig. 2.

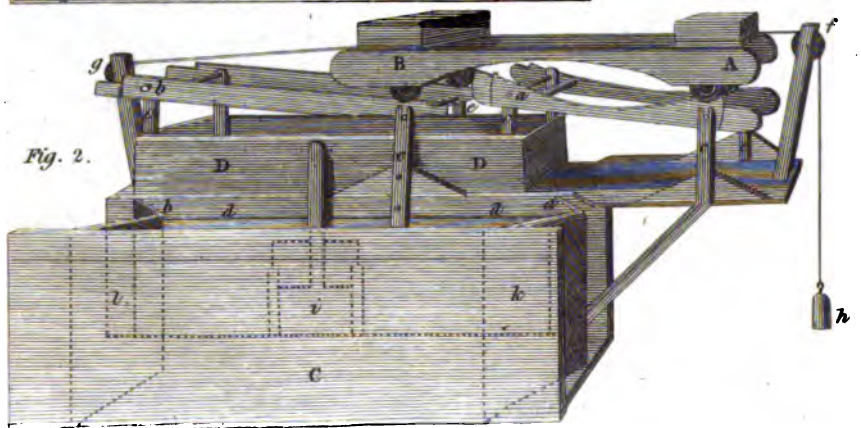
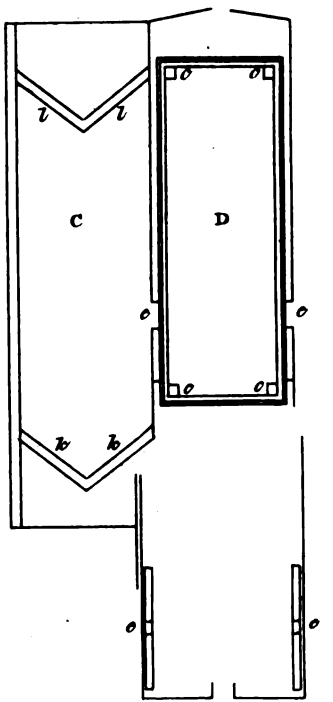


Fig. 3.



vantage, being only in contact with the upholding frames.

With respect to its operation, if any objections should be found to the great animal power that would at large be required, it will occur, that various other means may be used to put the carriage or load in motion; some without any loss of water, and others with a trifling loss, compared with what the lock holds. Thus, when the caisson is up, if, by a cock, a portion of water be let into it, the equilibrium will be destroyed, the caisson will sink, and the water in the lock be raised. Again, if by a pump, or other means, the water be returned from the caisson to the lock, the caisson will rise, and the load of itself recede, and this would be without waste of water. To put it in motion with a certain portion of waste, it is presumed, different ways may be found, as the introduction of a portion of water from the upper canal to the lock, or the discharging of it from the lock to the lower level; these would with management occasion the caisson to rise or fall; or, if a part of the load were made to shift farther from, or nearer to, the fixed standards *e e e e*, it would thereby cause the action required, and perform the operation; and, it is probable, that a better way than any here suggested would arise, should the thing be put in practice.

Method of improving Land lying Waste.

By Mr. WILLIAM TAYLOR, *of Beamish, in the County of Durham.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal or Thirty Guineas, at his Option, were voted to Mr. TAYORL *for this Improvement.*

I PURCHASED on the 27th day of May 1799, at a sale, 308 acres of common or heath land, over-run with whins, ferns, and obnoxious heath-grasses, springs, bogs, and spungy lands, for the sum of 2,665 *l.* without any buildings; and being no farmer before that time, I have it in my power to state the expense that has been incurred in draining this barren or waste land, and the utility it is to this country, to use every exertion to bring into cultivation the many thousand acres which at present lie waste, and where it cannot be improved, to convert it into plantations. The difficulties with which I had to contend at the outset were innumerable, and attended with great expense and inconvenience, having neither buildings nor food for my horses to cultivate the land, and hay was at that time 8*l.* *per* ton—160 stone, at 14lb. to the stone, and oats 6*s.* 3*d.* *per* bushel. In the summer months my ten horses grazed on the common; but in the winter I was obliged to seek shelter in the new buildings belonging to Sir John Eden, which were erected for his adjoining allotment; this cost me a considerable sum of money before I could reap any provender for my horses (which was a space of fifteen months). Having purchased so late as the 27th of May, I could get no produce that year. The draining, paring, burning, and making

making new hedges, was my first and necessary object to pursue. The drains have been made of various sorts, as described in my plan, some deep drains with flag-bottoms and side-walls, from eighteen to twenty inches in height, and well covered, and a quantity of land-stones for the water to ooze through into the drains. The greatest difficulty in draining was, where I met with running sands. Stones were of no use, as they sunk, (from the colliery borings made in the land it appeared the depth of sand and water was twenty-eight yards,) consequently I had recourse to prop-ends, from nine to eighteen inches long, (refuse wood left under-ground in collieries,) and strong whin shanks, and so made drains of a kind of trellis, or wicker-work; and these being light, may be called a kind of swimming drain, being well covered with a turf sod on straw, and have answered for upwards of three years extremely well, and no appearance of any failure, as I have had occasion to extend new drains into them, and found them entire. The land was in that state I could grow no hay for my work-horses, and it could not be expected for three years: it must be supposed the consumption of corn was great; but in this I experienced a considerable alleviation. At that juncture, Sir John Eden having extensive allotments, which I have had to manage and bring into cultivation, and on which was growing a considerable quantity of corn, he purchased a straw-chopper, that the horses corn might be mixed with straw (the number of horses employed in his colliery was considerable, and draught horses eighteen); this answered very well; but the manual labour to be done was severe, and took up much time; and having a thrashing-machine, I got the straw-chopper fixed to go by the same power, which answered the purpose completely; for two women can manage the feeding for 9*d.*

per day each; and when the thrashing-machine is not going, a boy to drive a galloway, and these two women, can perform more work than six men at 2*s.* 3*d.* each. The advantages arising from the use of this machine were so obvious, that I immediately procured one: but a few days experience convinced me, that a great improvement might yet be made, that if the machine would chop the oat sheaves, the thrashing would be saved, and the corn would be cut. Having the knives in good condition, the straw and oats were chopped, and so mixed, that they could not be swallowed unless well chewed. By giving my horses no corn by itself, as it is often wasted by their greediness of swallowing it, particularly old horses, I found upon calculation so considerable a saving by giving them their food in this way, rather than the general allowance of corn alone given to work horses, that from the commencement of using the straw-chopper my ten horses have not eat ten stone of hay each; I give them straw in the fold-yard, and their chopped straw and corn in the stable. I found it of the utmost utility to Sir John Eden and myself, to give to each man a fair proportion of this provender in bags, when they go to their day-work, allowing no hay; for it is well known to every experienced farmer, the loss he suffers by giving his men hay when they go from home; as frequently one-fourth part is left in the corner of the fields, or by the side of the highways. By the manner of feeding horses described, I can confidently say, one-fourth part of the value of the food is saved, and the spirits and condition of the animal superior to the common mode of feeding; and I have the pleasure to add, my servants are often complimented on the fine condition and sleek skins of the horses. I have with this report sent a small sample of the performance of the straw-chopper in cutting oat sheaves.

Having

Having no pasturage for my horses, the second year I summer-fallowed twenty acres of land of an equal soil; and in the beginning of August had the same sown with grass-seeds, and divided into four parts, with a different proportion of seeds, as a future guidance, to inform myself which answered the best; and herewith have sent you the result of the trial and expense, marked B in the plan. Also have presented an account of the weight and value of hay, the produce of five acres of drained land, as marked D in the plan; which, with the remainder of the field, was well summer-fallowed and limed, and sown the latter end of July 1802 with rye-grass and white and red clover, the whole produce of which was thirty-five tons.

The whole of the estate is now got into cultivation, except some patches of land that cannot be cultivated, and inaccessible banks. I have converted the best parts into nursery beds, which contain three acres of small pieces, in different parts; and have about seventeen acres of banks yet to plant, as my seedling trees advance.

Expense of Twenty Acres of Land laid to Grass.

B	£.	s.	d.	£.	s.	d.
Stubbing and burning whins as *per* bargain	20	0	0			
Paring, as *per* bargain	20	0	0			
Burning sods and spreading ashes,	7	10	0			
Ploughing at 12*s.* *per* acre (first time)	12	0	0			
Ploughing at 8*s.* *per* acre (second time)	8	0	0			
Harrowing twice, at 5*s.* *per* acre,	5	0	0			
Rape seed	2	4	0			
Draining, as *per* account	31	18	8			
	106	12	8			
Received for rape (a bad crop)	51	12	0			
				55	0	8

Fal-

Fallowing the same in the Autumn 1800, *and Summer* 1801.

	£.	s.	d.	£.	s.	d.
Thrice ploughing, at 8*s. per* acre	24	0	0			
Harrowing four times, at 2*s.* 6*d. per* acre	10	0	0			
Twice weeding and gathering, as *per* bill	22	18	0			
Lime, sixty fothers, slaking and spreading at 12*s.* 6*d. per* fother	37	10	0			
Grass seeds, as *per* account	22	18	8			
Harrowing and rolling, at 7*s.* 6*d. per* acre	7	10	0			
				124	16	8
Nearly 9*l. per* acre.				£.179	17	4

1801, August 1st—Sown with grass seeds, *viz.*

One quarter part, old land hay seed 10 bushels, white clover 7 pounds, *per* acre,	did not answer.
One quarter part rye-grass, one bushel *per* acre, white clover seven pounds *per* ditto.	Second year answered well for pasture.
One quarter part, half bushel rye-grass, three pounds of red clover, seven pounds white clover.	Answered the first and second year.
One quarter part, hay seeds, white and red clover, and hop clover.	Not so well.

From the former experiment it appears, that one bushel of rye-grass was over-much for an acre, as it choaked or destroyed a part of the white clover; this clover, which is apparently a native of heath-lands, (as may

may be observed in some parts of extensive commons that have never been in cultivation,) thrives well in most situations, and improves in quality the second year, as I have observed: I can say for no longer, as my land is not in a state to be continued long at grass, and I am pursuing the following state of cultivation. First, to fallow, clean the land well, and lay not less than three or four fothers of clod lime, equal to twenty-four or thirty-two bolls *per* acre, with a fair proportion of manure, and sow the same in the early part of June with turnips, to be eaten in the winter months with sheep, and sown in the spring with such kind of grain as I think the land best adapted for; and also, sowing six pounds of white and four pounds of red clover with half a bushel of fine rye-grass. The first year the seeds to be mown, the second year pasture, and the third year oats, and the following year to be fallowed, and so in rotation; and this scheme of husbandry I shall pursue, until I am perfectly satisfied the heath roots are sufficiently destroyed.

Drain D, described in the plan as being a pool of water, was sown with grass-seeds when fallow, containing five acres, in August 1802, and mown 14th day of June 1803. Produced 2 tons 14 cwt. of fine hay *per* acre, reckoning 160 stone *per* ton, which is equal to 13 tons 10 cwt. at 5*l.* *per* ton, amounting to 67*l.* 10*s.* and the fog, or second grass, was worth 25 shillings *per* acre for eatage.

This shews the utility of draining: and from the long experience I have had in the management of Sir John Eden's extensive drainage, I have always calculated at 30 *per cent.* profit; and in some situations I have proved draining to have paid the expense and rent the first year's crop, and the following year double the rent: this was to me a great inducement for engaging with so large a tract of waste and barren land to improve.

Cash

Cash Dr. to William Taylor, as expended on Pelton Grange Estate.

	£.	s.	d.
Casting drains as *per* bargain 3 feet deep — breadth at top 3 feet — at bottom 1½ feet; making the same complete as *per* plan, from June 21st 1799, to December 1801; 2½ years, being 19,257 yards, or 10 miles, 1657 yards - - - - - - - - -	367	1	0½
In 1802 and 1803—4,805 yards—2 miles 1,285 yards.—Total 24,062 yards, or 13 miles 1,182 yards - - - - - - - - -	140	2	11
A A. Making drains as *per* day's work, which could not be done by bargain, from 6 to 9 feet deep, in a black peat moss and running sand, and bringing up a drain B by the side of the high road, from 9 to 12 feet deep, walling and flagging the bottom. —Length, 208 yards, to prevent a runner of water overflowing several acres of flat land, and also to prevent the water from getting into a number of drains to the East. (See plan C C.) - - - - - - - - -	47	12	9
C C. Making drains as *per* day's work, in a black peat moss and running water, with sand 9 feet deep; also containing large bogs of water with fluent springs. When the water was drained off the ground lowered 6 feet - - - - - - - - - -	35	8	0
D. Making a large drain, 978 yards long and seven feet deep throughout; walling and flagging the same, to clear a parcel of ground, upwards of 5 acres, and a large feeder			

	£.	s.	d.
feeder of water; and also making an open drain to take off the day-water, which nearly overflowed this quantity of land in snowy and wet weather, and rendered it entirely useless, - - - - - - - - -	27	8	1
E. Bringing up levels out of Black-bourn, and draining a bog on a deep peat moss a considerable depth, to bring other drains through the same, - - - - - - - - -	23	0	0
F. Taking up a level in a place called Hereford Stells; to drain a lough, or deep pool of water, lying in the middle of a large piece of flat land. This drain was the whole length from 9 to 12 feet deep, 8 feet broad at top, and 4 at bottom, in a strong running sand, walling and flagging the same; here we unfortunately, from contending with water and sand, lost level, and this work is now doing over again, - - -	29	0	0
In 1802 and 1803 draining the above; bringing up levels 3 feet deeper, and making additional drains. First length 105 yards, from 11 to 14 feet deep, and 3,327 yards; 7, 8, and 9 feet deep; flagging, walling, and making the same complete, -	34	5	9
H H. Cutting Black-bourn by the side the high road; making a wall 6 feet high, and penning the bottom, to prevent the water overflowing a quantity of land, where it ran in a zig-zag form, - - - - - - -	16	9	9
Black-bourn, which runs through the middle of the estate, I was under the ne-			

	£.	s.	d.
cessity of cutting straight, it running in a zig-zag form; also in other places; and brought up levels to make drains into this little rivulet, which in wet weather overflowed several acres of land; and would have over-run a large quantity of deep drains C C. The same is by measurement, in length 1188 yards, at 5*d.* *per* yard; being 4 feet deep, 4 feet broad at top, and 3 feet at bottom; this is upon a vague calculation, as no account was kept, but was in the general account of expenditure, - -	24	15	0
G G. Cutting Twizell-bourn straight, a rapid running water, and cutting through a hill where the drain was 50 feet deep; piling and fendering, which gained a quantity of haugh-land, and covering the old bourn-way with soil. I have not the particular days works, as they are in the general account of expenditure, but am certain they would exceed - - - - - - - - -	55	0	0
Stubbing whins, and burning *per* account, 180 A. 2 R. 3 P. - - - - - - -	162	7	8
Paring, burning, and spreading ashes *per* account, 190 A. - - - - - - - - -	262	0	0
Making new hedges, planting 79,258 quick-sets—posts, rails, and nails—11,394 yards, or 6 miles, in 1½ years, cost, as *per* account of particulars, 4*s.* 1*d.* *per* rood, -	335	3	8
36 new gates, loops, crooks, &c. and hanging, - - - - - - - - - - - - -	41	8	0
Lime 183 fothers, laying on and spreading, at 12*s.* 6*d.* in 1800 and 1801, - - -	114	16	0

Lime

	£.	s.	d.
Lime 215 fothers, laying on and spreading, at 12*s.* 6*d.* in 1802 and 1803, - - -	134	7	6
Seedling forest trees, and 34 bushels of acorns, - - - - - - - - - - - - -	25	14	6
Expended in buildings, cultivation of lands, horses and implements of husbandry, &c. over and above the sum received for the produce of the farm, *viz.* 1,996*l.* 6*s.* 6*d.*	1714	7	11
£.	3799	18	4½

Annual Expense from the Commencement, viz.

	£.	s.	d.	£.	s.	d.
From the 27th May 1799 to the 31st January 1801, -	2168	4	6			
Received in the above time,	151	18	0			
One year and seven months				1916	6	6
Expended from the above time to 22d November 1801, *viz.* - - - - -	2246	9	5			
Deduct on account of purchase money, - - - - -	1000	0	0			
	1246	9	5			
Received in the above time,	384	4	6			
				862	4	11
Expended from the above time to 22d November 1802, - - - - - -	3059	6	6½			
Deduct in full for purchase money, - - - - - - -	1665	0	0			
	1394	6	6½			
Received in the above time,	605	0	9			
				789	5	9½

	£.	s.	d.	£.	s.	d.
Expended from the above time to 22d of November 1803,	1087	4	5			
Received in the above time,	855	3	2			
				232	1	2
Expended over and above what has been received,				3799	18	4½
Purchase as above,				2665	0	0
				£. 6464	18	4½

Total draining per *Plan.*

	Miles.	Yards.
1st as *per* account of plan	13	1182
A A	0	208
C C	0	886
D	0	976
E	0	467
F	0	105
F 2d time of making complete	1	1567
H H	0	108
Black-bourn open drain, as *per* plan	0	1188
G G ditto	0	1260
Total	18	907

Valuation of Stock at Martinmas, 1803.

	£.	s.	d.
1420 thraves of oats, at 7*s.*	497	0	0
518 ditto of maslin, at 10*s.*	259	0	0
50 ditto of barley, at 5*s.*	12	10	0
Turnips	140	0	0
26 acres of maslin, sown at 3*l.*	78	0	0

30 tons

		£.	s.	d.
30	tons of hay, at 5*l.*	150	0	0
10	horses	168	0	0
	Carts, ploughs, and harrows	87	0	0
1400	yards of hurdles, at 6*d.*	35	0	0
2	cows	28	0	0
	Cattle in hand	359	15	5
	Swine	16	0	0
	Valuation of nursery trees, *per* account	123	11	0½
	Thrashing-machine	60	0	0
	Straw-chopper	12	0	0
2	winnowing-machines	15	0	0
	Old oats sold	17	14	0
		£. 2058	10	5½

Valuation of Pelton Grange Estate, in the Parish of Chester-le-Street, in the County of Durham, belonging to William Taylor, Esq.

Quantity.	Tenure.	Average value *per* acre.			Annual value.			Years purchase.	Total value.		
Acres.		£.	s.	d.	£.	s.	d.		£.	s.	d.
151	Freehold	1	4	0	181	4	0	27	4892	8	0
75	Copyhold	1	7	6	103	2	6	24	2475	0	0
59	Leasehold	1	7	6	81	2	6	18	1460	5	0
22	Do. to plant	0	10	0	11	0	0	18	198	0	0
307					376	9	0		9025	13	0

The above is a fair valuation of the estate, according to the best of my skill and judgment. JOHN FRYER.

Newcastle, 24th March, 1804.

Total

Total Expense.

	£.	s.	d.
Purchase	2665	0	0
Title obtaining	176	9	3
Buildings (no farm house)	935	0	0
Draining, hedging, planting quicks, nurseries, *per* account	1960	10	5½
Agency for self 2½ years (afterward got a person to manage)	125	0	0
Interest due on the purchase, and on money expended from the commencement to Nov. 22, 1803	750	0	0
Incidentals, horses, taxes, and cesses	477	18	7½
	7089	18	4
Valuation of stock at Martinmas, 1803	2058	10	5½
	£. 5031	7	10½

Valuation of the estate made by Mr. John Fryer, as *per* account annexed	£. 9023	s. 13	d. 0
Expended as above	5031	7	10½
Gain	£. 3992	5	1½

	£.	s.	d.
Valuation of stock at Martinmas, 1803,	2058	10	5½
The former year's valuation	1353	15	6
	£. 704	14	11½

Brought

	£.	s.	d.	£.	s.	d.
Brought forward - - - - - -				704	14	11½
This year's payments - -	1087	4	5			
Deduct incidental charges for obtaining title, included in the above sum - - - -	176	9	3			
	910	15	2			
This year's receipts - - -	855	3	3			
				55	1	1
Gain - - - - -				£. 649	3	0½

Valuation of Forest Trees in the Nursery, November 25, 1803.

				£.	s.	d.
163516	Oak trees	at 10*s.*	*per* thousand -	81	15	2
12574	Quicks	at 7*s.* 6*d.*	ditto - -	4	13	8½
16740	Beech trees	at 11*s.*	ditto - -	9	4	1
3540	Silver firs	at 23*s.*	ditto - -	4	1	6
1436	Larch firs	at 30*s.*	ditto - -	2	3	0
560	Alders	at 20*s.*	ditto - -	0	11	0
714	Scotch firs	at 10*s.*	ditto - -	0	7	0
4000	Larch	at 15*s.*	ditto - -	3	0	0
4400	Hazels	at 30*s.*	ditto - -	6	12	0
1200	Hollies	at 5*s.*	ditto - -	0	6	0
666	Ashes	at 10*s.*	ditto - -	0	5	6
576	Sycamores	at 10*s.*	ditto - -	0	5	7
				£. 113	4	6½

Planted

	£.	s.	d.	£.	s.	d.
Brought forward - - - - - - - - - -				113	4	6½
Planted in 1802 *and* 1803.						
2300 Larches, at 2*l.* *per* thousand	4	12	0			
1500 Oaks, at 3*l.* ditto -	4	10	0			
500 Scotch firs, at 25*s.* ditto -	0	12	6			
300 Beeches, at 2*l.* ditto -	0	12	0			
				10	6	6
Received of the Honourable Lord Eldon (by Sir John Eden) for oaks to plant on his Eldon estate, - - - - - - - - - -				12	0	0
			£.	135	11	0½

A large quantity of forest seeds sown in 1803, which cannot be ascertained.

Certificates received from Mr. Matthew Forster, of Broomyholme, and from William Nesfield, Esq. one of his Majesty's Justices of the Peace for the county of Durham, confirmed the above statements, and that the ground now produces rich and abundant crops.

Description and Use of a Calorimeter, or Apparatus for determining the Degree of Heat, and of the Saving that may be made in the Fuel employed. By M. MONGOLFIER.

With an Engraving.

From the JOURNAL DE MINES.

TO economise fuel is one of the most important objects in all processes relating to the arts, especially in chemical operations; it is equally useful to know what advantage or saving there is, in employing particular kinds

kinds of fuel, and to ascertain the quantity of caloric which is disengaged from the substances that are burnt.

The same quantity of different species of fuel does not always give the same degree of heat; and it requires a longer or shorter space of time to be disengaged from the fuel employed. The success of an operation very frequently depends on the promptitude with which it is performed. Therefore to manufacturers, distillers, and farmers, it must be highly desirable to know what kind of fuel is the cheapest, or what is the proportion of a given quantity to a like quantity of another, in regard to the effect which ought to proceed from it; in short, that method which is the most certain and the easiest of determining the difference of the action of the caloric. M. Montgolfier, to whom we already owe so many useful discoveries, has resolved this question by the invention of an apparatus, which he calls a *Calorimeter* *.

Description of the Calorimeter.

Fig. 7 (Plate XVII.) represents a section of the calorimeter invented by M. Montgolfier.

A B C D is a case or box of tinned iron (it would be more economical and advantageous to have it made of wood), which should be perfectly water-tight. A cover A B is adapted to it, having an opening at *a b*; at the bottom is a similar opening *e*. *a b c d e f* is a small sheet-iron stove, (it is better to make it of copper,) carefully closed, that it may not leave any passage for water. Its lower opening corresponds with that of the case at *e f*. Another in the upper part is closed near *a b* by a stopper which may be removed at will. *c d* is a grate, composed

* This apparatus differs essentially from the calorimeter adapted to chemical experiments, invented by Messrs. Lavoisier and Laplace.

of wire net-work, on which the fuel is placed; the ashes fall under the grate through the opening *g*. Near to *h i* is attached a pipe *k k*, for the purpose of affording a passage to the smoke, which escapes through the opening *l*: this pipe should be constructed of iron or copper, in such a manner as not to suffer the water which surrounds it to penetrate it. *m m* is an iron pipe, larger than the former, and which it should surround, that the water may enter the space between the inside of the large pipe and the outside of the smaller one. E is the reservoir; the cover of which, *r s*, may be raised, in order to fill the apparatus with water. *o* is a canal, proceeding from the reservoir, and communicating with the pipe *m m*. *n n* is another pipe, which passes from *m m* into the case, and which serves to introduce the water into it after it has passed through the pipe *m m*. *p* is a cock by which the boiling water may be drawn out, and *q* is a similar one, by which the apparatus may be emptied when required. F G are the feet which support the apparatus.

Use of the Calorimeter.

When it is used to determine the space of time necessary for different kinds of fuel to disengage an equal portion of heat, the reservoir E is filled with water. It passes through the pipe *o o*, rises in the pipe *m m*, and enters through the canal *n n* into the case A B C D. As much water is poured in as is necessary to fill the case, and which may be easily ascertained, since it does not then descend below the line *t u*, which is the most elevated point of the water in the apparatus; and its temperature is taken by means of a thermometer. A quantity of fuel, sufficient for the experiment, (wood cut into small pieces for instance,) is then placed upon the grate *c d*: when it is lighted the upper opening of the stove *a b* is

is closed with the stopper, and it should be noted how much time is required for the water to arrive at a certain degree of heat; for example, till it boils; this may be done by means of a thermometer. The fire is then taken out, and the water and the stove are left to cool till they return to their first temperature, when the operation commenced. Another kind of fuel, such as pit-coal or turf, is then placed on the grate, the fire is lighted, and proceeded with as before. The degree of facility with which the heat is disengaged from the combustible is shewn by comparing the length of time required by the two experiments.

To find the difference in the quantity or weight of various kinds of fuel proper to produce this equality of temperature, a sufficient quantity of one kind of fuel (a piece of wood for example, and we will suppose it a cubic foot) must be placed in the stove, and lighted, the apparatus being previously filled with water, and its temperature noted. The thermometer ascertains the instant at which the water boils. The fire is then extinguished, what remains of the combustible is taken out of the grate, and when the whole has returned to its first temperature the process is repeated with another kind of fuel.

If the different quantities of fuel employed are compared at the end of the operation, and are estimated at a mean price, it will be easy to determine which is most advantageous. I shall farther observe, that the pipe *m* may be constructed of wood; but if it be made of iron or copper it should be surrounded by a covering of several leaves of paper, disposed one upon the other; by this means less heat is lost.

The pipes *k k* and *m m* may be lengthened at will, because still much heat escapes at the opening *l*.

This apparatus will serve for various purposes, such as to boil water at a little expense. It is very useful in domestic economy. To render its effect complete, the smoke, or rather the burnt air, should be deprived as much as possible of its caloric, which ought to be entirely employed in augmenting gradually the temperature of the water which envelopes the chimney. This air thus cooled, being heavier than that of the atmosphere, determines in the furnace the current of air, which can only be obtained in upright chimnies by sacrificing a very considerable quantity of heat. Consequently it is best to make the chimney as long as the height of the apartment will permit.

On making Turf into Charcoal. By M. PLATEL,

(Concluded from Page 375.)

IN an apparatus disposed as I have described, I put more than five and twenty kilogrammes of dry wood, to obtain a perfect idea of its advantages, and the following were the results.

After the gas had been disengaged with turf of a good quality, obtained by pressure, it inflamed with vehemence, and in about an hour furnished a quantity of radiant heat, so considerable that the openings of themselves, without any addition of combustible matter, were able to continue the operation, producing in the end perfect homogeneous charcoal; and I own I was highly pleased with this sight.

Indeed, how can one see without admiration a combustible substance burn itself, saving at the same time the half

half of a similar combustible which must have been used to produce an equal quantity of charcoal *.

I must not omit to speak of the use of pressed turf for economical purposes; for instance, experience has proved to me, that turf of a good quality, which has been pressed and well dried, is capable of producing quantities of heat in the following cases.

Five or six parts of turf are equal to four of wood, admitting that the fire-places admit the air freely; there is therefore a great advantage in burning turf that has not been pressed, since it produces from two to three, and even four, times as much as wood; and if we consider the value of these two combustibles, we shall see that for the same expense we can burn three times as much turf as wood.

But the public will not employ this economical method, alledging that turf has a disagreeable smell †, and that it heats slowly.

All these difficulties will vanish, if the furnaces are constructed something like those which are used in England to burn coak, or charcoal more or less pure; and, I must add, that I have known persons who were prejudiced against innovations, congratulate themselves on having made a trial of this method of constructing furnaces, for the sake of making use of a combustible which formerly they hardly condescended to notice. (See Figs. 5 and 6, Plate XV.)

Turf does not always yield the same quantity of charcoal, and consequently the quantity of ashes will vary accordingly.

* We ought not to neglect to acknowledge the thanks due to M. de Jean for the method he has published for the extraction and preparation of turf as used in Holland; there is no doubt of the superiority of this method.

† This smell only exists in unprepared turf.

accordingly. I have seen turf produce from 0,38 to 0,40 of charcoal, which by incineration yielded from 0,17 to 0,18 of ashes.

I do not speak of a certain kind which has yielded me 0,50 of ashes, because from that 0,50 must be subtracted 0,35 of ferruginous earth which they contain.

The turf employed in my works, after a successful operation, yielded from 0,38 to 0,42 of charcoal, producing by incineration from 0,13 to 0,16 of ashes; but I believe that, considering the saving occasioned by the gas, we might by some trifling improvements raise the quantity of charcoal to 0,50. The quantity of charcoal produced by good turf may be looked upon as very considerable, particularly when it is compared with that produced by sound wood. Fifty kilograms of the wood of oak therefore separated from its sap, and fifty years old, on a trial, will be found, with the help of heat, to furnish from 0,20 to 0,21 of charcoal, and 0,02 to 2,05 of ashes.

In a word, three parts of turf when pressed, or of a good quality, and a fourth part of wood that burns briskly, is sufficient for burning bricks, tiles, and common earthen-ware; and experience has assured me, that the earthen-ware is equal to any that is made for domestic purposes.

To obtain these results, I constructed a furnace such as I have described.

The preparation of the paste for the different kinds of earthen-ware must not be forgotten, since it forms the base of my work.

I have mentioned above, that the oily products obtained in any condenser whatever may be rendered useful.

These products are often divided into two beds: the first is water slightly charged with oil, and containing acetous

acetous acid, or acetic; the second is black oil, heavy, acrid, very penetrating, ropy like tar, and difficultly soluble. It may be put to various uses, as for instance, to oil coarse machinery, owing to the vegetable acid it retains; and in this case the two substances mixed and separated from a part of the phlegm may be used.

The rectification of these oils furnishes a certain quantity of acid, by the aid of which I have prepared the solution of iron called by the workmen iron liquor; but it is proper to add a little concentrated acetous acid, to prevent the iron from precipitating in an oxyd. By a similar solution, and a particular method, I have made patterns of black upon pieces of woollen, cotton, and silk, not inferior to any common black; I could even produce a very fine nankeen colour. The Indian buffs might be made with this acid, by thickening these colours with starch or gum, according to their quality and shade *.

In short, I am persuaded that it is possible to oxydate copper with this acid, which acid is perhaps less plentiful in turf than wood.

To procure that transformation of copper called verdegris, the pulp of a particular kind of cyder-apple, which is in all Normandy thought useless, may be used; it must be tempered, as soon as it is made, with bad sour cyder, in order to bring it to a proper degree of acidity. Then the plates of copper are put with this pulp, layer upon layer, in earthen pots or little casks; the oxydated plates are washed in about a month with

* What I have said respecting iron dissolved in acetous acid may be extended to the use of empyreumatic oil in dyeing woollens, &c. and to many other processes too long to be enumerated.

the

the acid, and the operation is completed according to the method prescribed by M. Chaptal *.

It is to M. Lefibure that I owe the first idea of using the pulp of apples in the preparation of acetate of copper.

If the facts related in this memoir prove interesting to science, and of some use to such as may think proper to try them, all that I desire will be accomplished †.

Explanation of Plate XV.

Figs. 1 and 2, a front-view or elevation of the furnace, and Fig. 3 the plan. Q Q the roof. M M the chimney, the form of which may be varied. B B B B circles of iron with pins, as at H H. L L small ventilators, to accelerate at will the combustion in the furnace. *q* the door to the furnace. K the ash-hole, formed something like a cone placed horizontally. A *a* the tubes that convey the gas proceeding from the thermolampe into the condenser. E *e* keys to prevent the external air from communicating with the charcoal while warm. C *c* tubes serving to reconvey the uncondensed gas into the fire-place. F *f* condensers employed occasionally. F a stone hollowed out and covered over. *f* a tub or cask. S S re-

* The fruits of a number of wild plants may be rendered useful in this way; such as the sloe, or *prunus spinosa* of Linnæus. When they have been bruised they form a pulp, which will oxydate copper, being washed after a month's draining with the above-mentioned acid.

† On the very day that this memoir was presented, I was informed by M. Vauquelin, that M. Lebon, an engineer, had applied to the carbonisation of wood a process nearly similar to mine; and I shall merely perform an act of justice in agreeing with M. Vauquelin, that no apparatus could be better contrived than M. Lebon's; and in this instance he has shewn himself to be a man of such ingenuity as to command the admiration of philosophers.

present

present the cocks or plugs at which the distilled liquors are taken out.

Fig. 2 the thermolampic or carbonising apparatus. A *a* tubes proceeding from the furnace. B the hook retaining the part that opens on the side where the brick-work has a door composed of dry bricks, which are placed and withdrawn at each operation.

Fig. 4 view of one end of the apparatus.

The dotted lines in all the figures express the hidden parts.

Fig. 5 an inner view of the furnace prepared for burning turf and its charcoal: by this construction the disagreeable properties of the turf are avoided. A the frame of the furnace. B a plate of metal rising and falling by the help of two lateral grooves, and by means of two copper buttons shewn at C C. E the back part, formed of a cast iron plate, inclined towards the upper part. D D the chimney. F F are sides, forming with the bottom an angle of 135°. G the grate: by this construction the combustible turf is isolated, which only requires a strong current of air to make it burn. H shews the length of the bottom of the box, formed like the other part of cast iron. I the ash-hole, with the bottom a little hollowed towards the back, which gives it more depth. K K K rollers on which the ash-hole moves.

Fig. 6 a vertical section of the furnace and chimney. A the frame. B the front plate, or regulator of the combustion. E the cast-iron back, bent so as to leave but one opening for the smoke four inches wide and sixteen long, or fourteen at least.

It must be observed, that this plate does not reach to the top, and that its line is continued along the dry bricks, to facilitate their removal. G shews the form of the fire-place where the turf or charcoal is put.

Extract from a Memoir on Sulphuric Acid, read to the Phylomatic Society at Berlin.

From the ANNALES DE CHIMIE.

THE object of this memoir is to determine the respective quantities of the elements of sulphuric acid and of the sulphate of barytes. It recites the analyses that have been made of these substances by the undermentioned chemists.

Sulphuric acid is formed, according to

	Lavoisier.	Bertholet.	Thenard.
Of sulphur	0.69	0.72	55.56
Of oxygen	0.31	0.28	44.44

	Chenevix.	Tromsdorf.	Richter.
Of sulphur	51.50	70.00	42.05
Of oxygen	38.50	30.00	57.95

	Bucholz.
Of sulphur	42.05
Of oxygen	57.05

From the above results, we see, that the analyses of Messrs. Richter and Bucholz, though produced by different processes, are those which are nearest alike, and consequently they are most to be relied upon.

M. Klaproth, however, thought it proper to ascertain, by his own experiments, the respective quantities of the elements of sulphuric acid, that he might enable himself afterwards to apply the results with more certainty to the analysis of pyrites or metallic sulphurets. To attain this object, he has, like his predecessors, made use of nitric acid and carbonated barytes: the proportions of the elements

ments in the latter have been formerly ascertained in the first volume of M. Klaproth's work: they are 78 of barytes and 22 of carbonic acid.

But M. Bucholz having since asserted, that there is in this salt 79 of barytes and 21 of carbonic acid, M. Klaproth has repeated his analysis once more; and notwithstanding all his care, he has found the proportions to be the same as before. It is thus that M. Bucholz admits but 25 of carbonic acid in strontian, while M. Klaproth has found 30 in all the analyses which he has made of this substance.

The results obtained from the analyses of sulphate of barytes made by divers chemists are no less various.

It is composed according to

	Fourcroy.	Clement and Desormes.
Of barytes	66.00	67.82
Of sulphuric acid	34.00	32.18

	Thenard.	Chenevix.	Kirwan.
Of barytes	74.82	76.50	67.00
Of sulphuric acid	25.18	23.50	33.00

	Richter.	Bucholz.
Of barytes	69.00	67.00
Of sulphuric acid	31.00	33.00

If the analyses of Messrs. Chenevix and Thenard be excepted, we see that all the rest very nearly resemble each other; and if we take the mean, that of Kirwan will be nearest to the truth; for which reason M. Klaproth has adopted it.

It is here necessary to shew the means employed by M. Klaproth in his researches: he introduced 200 grains of pure sulphur and 8 ounces of pure nitric acid into a retort; the acid having a specific gravity of 1.320, he

distilled it, till about three quarts had passed into the recipient. The produce of the distillation was put again into the retort, and distilled a second time; he then added 8 ounces of acid, and recommenced the distillation of the whole.

M. Klaproth has found that the unburnt sulphur weighed 48 grains and a half; he had therefore 151 converted into sulphuric acid. The produce, diluted with a certain quantity of water, was mixed with muriate of barytes, till no more precipitate was produced in the liquor. The sulphate of barytes, when well washed and dried, weighed 1109 grains, but when calcined in a platina crucible its weight was reduced to 1082 grains.

To ascertain the proportions of the constituent principles of concrete sulphuric acid, M. Klaproth took 100 grains of sulphuric acid highly concentrated, the weight of which was 1.850; he diluted it with fifteen parts of water, and poured into it some muriate of barytes, till it ceased to form a precipitate. The sulphate of barytes, carefully washed and dried, weighed 225 grains. The result from these facts is, first, that 100 parts of sulphuric acid, of the specific gravity of 1.850, are composed

Of concrete acid -	74.04	or of sulphur -	31.05
and of water - - -	25.06	oxygen - - -	42.09
		water - - -	25.06

Secondly, that 100 parts of concrete acid are formed

Of sulphur - - - - - - -	42.03
Of oxygen - - - - - - -	57.07

Thirdly, that 100 parts of calcined sulphate of barytes contain

Barytes - - - - - - - -	67.00
Sulphur - - - - - - - -	14.00
Oxygen - - - - - - - -	19.00

Memoir

Memoir on the Decomposition of Water, and of the Bodies which it holds in Solution by the Aid of Galvanic Electricity. By C. J. T. DE GROTTHUS.

(Concluded from Page 370.)

CHAPTER II.

Theory of the Decomposition of Liquids by Galvanic Electricity.

§ 15. THE decomposition of water by the electromotive apparatus has for a long time exercised the sagacity of chemists and philosophers, to whom this phenomenon presented a problem difficult to resolve, so as to reconcile it with the theory relative to the nature of water. It was necessary first to ascertain whether the two products at the two Galvanic poles proceed from one and the same molecule of water, or from two different molecules; and in the latter case it was asked, what becomes of the hydrogen at the place where nothing but oxygen is perceived; and again, what becomes of the oxygen at the place where hydrogen alone manifests itself?

§ 16. The column of Volta, which immortalizes the genius of its inventor, is an electric magnet, of which each element, (that is to say, each pair of disks,) possesses its positive and its negative pole. The consideration of this polarity has suggested to me the idea, that a similar polarity might perhaps establish itself between the elementary molecules of the water, solicited by the same electric agent; and I confess that this seemed to me a ray of light.

§ 17. Let us suppose then, that at the moment of the incipient separation of the *hydrogen* and *oxygen*, there takes place in these two bodies, whether by the contact

or

or by the friction of the one against the other, a division of their natural electricity, so that the first acquires the *positive* and the second the *negative* state; it follows that the pole from which incessantly issues the resinous electricity, will attract the hydrogen, and repel the oxygen, whilst the pole endowed with the vitreous electricity will attract the oxygen, and repel the hydrogen *. Thus, when the Galvanic current traverses a quantity of water, each of the two component principles of this liquid is solicited by an attractive and by a repulsive force, whose centres of action are in reciprocal opposition, and which, acting in the same direction, determine the decomposition of the water.

§ 18. The action of each force with respect to a molecule of water situated in the line of the Galvanic current, is in the inverse ratio of the squares of the distances at which it is exerted. But since the distance of any molecules placed between the two centres of action, can never diminish relatively to the one without increasing, in proportion to this diminution, relatively to the other, each of the elements of such molecule is solicited by a constant force which results from the attractive and from the repulsive force †.

The effect of the repulsion, though actually existing, is not sensible on account of the reciprocal action of the elementary molecules in contact, whence results a recombination of those which the Galvanic poles repel.

* Considering the diversity of the substances deposited at the negative pole, it would be more simple, and perhaps more just, to admit only an attractive and a repulsive force acting upon the oxygen, without attributing any to the poles with regard to the hydrogen.

† I suppose each force to have the same intensity, which must actually be the case, since neither of the poles of the electromotive apparatus can acquire electricity but at the expense of the other.

§ 19.

§ 19. Let us now consider a certain quantity of water, composed of oxygen, represented by the negative sign (—) and hydrogen marked by the positive sign (+), see Fig. 7, Plate XV. At the moment when a Galvanic current is established in this water, the electric polarity manifests itself between its elementary molecules, in such a manner that these shall seem to constitute *the complement of the pile in action.* At the same time all the molecules of oxygen, situated in the line of the current, will have a tendency to move towards the positive pole, while all the molecules of hydrogen situated in the same line will tend to arrive at the negative pole.

Hence it results, that when the molecule of water, represented by *o h*, yields its oxygen *o* to the vitreous fluid of the wire +, its hydrogen *h* is immediately re-oxygenated by the arrival of another molecule of oxygen *o*, of which the hydrogen *h'* recombines with *r*, &c. &c. The same circumstance takes place, but in a contrary sense, with respect to the molecule of water Q P, which, as it yields its hydrogen Q to the resinous fluid of the wire —, is immediately *rehydrogenated* by the arrival of the molecule X; and this successive decomposition and recombination of the elements of water will continue till it is completely decomposed.

§ 20. It is evident that, in the whole of this operation, the molecules of water situated at the extremities of the conducting wires will alone be decomposed, whilst all those intermediately placed will exchange reciprocally and alternately their component principles without changing their nature. Hence, I conclude, that if it were possible to establish a current of Galvanic electricity in water, so as to describe in it a perfectly circular line, all the molecules of the liquid situated in this circle would be decomposed and at the same instant recomposed; whence

whence it follows, that this water, though undergoing the effect of the Galvanic action, would still always remain water.

§ 21. Having exposed liquids contained in two or more vessels to the action of the electromotive apparatus, I perceived the polarity at the extremities of the metallic wires, which served to establish the communication between the liquid contained in each vessel. (See Fig. 8.) Thus, when the vessels contained acetate of lead dissolved in water, I obtained oxygen at the extremities, *a* and *c*, whilst the vegetations already described took rise at the extremities *b* and *d* *.

Having brought the vessels close to each other, and shortened the dimensions of the wire *b* and *c* as much as it was possible for me to do, the electric polarity nevertheless manifested itself distinctly; and here, if we imagine the same wire *infinitely small*, the mind can conceive how the molecules *n* and *p* will unite and regenerate the body which at first was decomposed.

§ 22. The theory of the decomposition of the water which I have just laid down, leads me to draw some inferences.

a. The proportion of hydrogen cannot be increased in that part of the water which is next to the positive pole, since the oxygen of the whole quantity of liquid, traversed by the Galvanic current, tends to move towards this point, whilst the hydrogen tends to remove from it.

b. An oxygenation in the part of the water which surrounds the negative pole is equally impossible, since the

* I have communicated my memoir to M. Moriehini. This able chemist told me that he had obtained a similar result in examining the gases which are disengaged when the vessels contain only water. The extremities *a* and *c* gave him the oxygen gas, whilst the hydrogen gas was evolved from the extremities *b* and *d*.

hydrogen

hydrogen is constantly attracted to it, while the oxygen is repelled from it. (See § 9.)

c. Even though the component principles of water were susceptible of any other proportion of combination than that which constitutes water, this would no less be decomposed in the manner described; but there would be neither oxygenation, nor hydrogenation, nor acidity, nor alkalinity in any part.

§ 23. The production of an acid at the positive pole, and that of an alkali at the negative *, in water, acted upon by Galvanic electricity, give additional support to the theory proposed; for, according to analogy, the first must be attributed to an oxygenation, and the second to the presence of hydrogen †. (See § 9.)

My apparatus having remained several days in action, the cloths moistened with a solution of muriate of soda were covered in different places with a saline efflorescence, which was nothing more than soda combined with carbonic acid, which it had absorbed from the air.

§ 24. The polaric arrangement, such as it exists in the elementary molecules of the water traversed by the Galvanic current, must be equally established among the elementary molecules of any other liquid body, provided they be actuated by the same forces. In the metallic solutions the electric polarity takes place between the elements of the oxyd, of which the oxygen passes to the

* The tincture of turnsole, traversed by the Galvanic current, becomes red round the positive pole, and re-assumes the blue colour when the respective position of the two poles is changed; but these effects may be explained by the action of the oxygen and of the hydrogen, at the moment of their developement upon the colouring matter, but are not sufficient to prove the presence of acidity and of alkalinity.

† Hydrogen is one of the constituent parts of volatile alkali, and oxygen enters into the composition of all the acids with the nature of which we are acquainted.

positive pole, and the metallic particles which it held in solution; but being decomposed, whether by this reaction or by the electric power, the revification no longer takes place.

§ 25. I filled a curved tube with two different metallic solutions in such a manner that each of them, without being mixed with the other, occupied one half of the tube, and that they had a single point of contact in the middle *. When the two liquids thus arranged were exposed to the action of the Galvanic current, and the *negative pole* plunged sometimes into the one, sometimes into the other, it was always lined with revifified metal in the solution in which it was immersed.

If we knew any other substance besides oxygen that could be actuated by the positive pole, we might repeat the same experiment with regard to it. An analogous result would then evidently prove that the decomposition of water by means of Galvanic electricity is effected with relation to two different molecules; an opinion which is generally admitted, and conformable to the theory which I venture to submit to the examination of the learned..

The admirable simplicity of the law which governs this phenomenon, we observe also with astonishment in the law of the universe. Nature can neither *create* nor *destroy*, for the number of bodies is never either augmented or diminished; but all, without exception, are subject to the *mutual interchange* of their *elements;* and when we contemplate the wonderful effects of electricity, which frequently acts in secret, though diffused throughout the universe, we cannot hesitate to acknowledge in it one of the most powerful agents in the grand operations of nature.

* This may easily be effected by employing two solutions of different colours; for example, of acetate of lead and of nitrate of copper.

On the Means of preserving Water in long Voyages, and their Application to the Preservation of Wines.

From the ANNALES DE CHIMIE.

IN 1803 M. Berthollett communicated to the class of mathematical and physical sciences of the Institute, the result of an experiment on the property of charcoal for preserving water. Four months before, he had filled two casks with water, one of which had been burnt in the inside: the water which it contained proved drinkable, and had no bad taste; that which had been put into the cask not so prepared, was so much spoiled that the smell was insufferable.

The Court Gazette of Petersburg, of the 30th of May last, published an account of the success obtained by Captain Krusenstern by this process.

He writes from Kamschatka, July 8, 1805, to M. Schubert, of the Academy of Petersburg, that during his stay at Copenhagen he met with a journal where this process was described by a French chemist, and that he immediately burnt the inside of from fifty to sixty casks.

During his stay at Brazil M. Krusentern proceeded to burn the greatest part of his casks; and for the whole of his voyage, till he arrived at the isles of Washington, the water from the burnt casks was always good. To preserve the salubrious properties of these vessels he preferred suffering the inconvenience arising from an inequality of ballast to filling them with sea-water as they were emptied, (which is the custom in ships of war,) because it hastens the corruption of the fresh water which is afterwards put into them. When arrived at Japan he burnt, as strongly as possible, all his water casks without exception; and the success of this proceeding was still

farther manifested during a voyage of seven weeks to Kamschatka.

" Our water," he says, " was constantly as pure and good as that from the finest spring; thus we shall have the honour of being the first to put into practice a process as simple as it is useful; and perhaps the French chemist will learn our happy success with pleasure."

A fact so important ought naturally to find a place in these Annales: this being observed by one of the editors to M. Berthollet, he has addressed the following letter to him.

" *July* 2, 1806.

" As you have signified, my dear colleague, a desire of inserting in the " Annales de Chimie," a note concerning the experiment of M. Krusenstern, on the process of carbonising the interior of casks in order to cause them to preserve the water without alteration in voyages by sea, I shall make some observations on this subject, which you will use as you shall think proper.

" The bed of charcoal acts in two ways: First, it opposes the dissolution of the extractive part of the wood; second, it prevents the putrefaction of that which might dissolve those portions of wood which have escaped carbonisation, or which the charcoal has detached.

" If we are contented with putting charcoal into the cask, or with correcting the putrefaction by means of filters containing powder of charcoal, the first effect will not be obtained, and even the second will cease to be produced at a certain period, when the properties of the charcoal are exhausted.

" The process of carbonising the inside of casks may likewise be used with advantage for the preservation of wines. First, the wine will dissolve, as water does, the extractive part of the wood; and its flavour, especially when

when it has naturally no predominant one, will not be altered; for this reason casks which have been much used are preferable to such as are newly made. Secondly, this extractive part probably favours the acid fermentation, which is facilitated in voyages by a successive agitation and a high temperature: on which account many kinds of wine will not bear either the sea or long journeys.

Wine when sufficiently clarified improves in bottles: is it not because it is there preserved from the extractive part of wood; and may it not be conjectured that it would be still more agreeable if preserved in casks, the interiors of which have been carbonised, and which, by that means, would not only perform the office of stone or good glass, but, by containing a large quantity, would encourage this last fermentation, which matures its qualities?

"Spirituous liquors likewise dissolve the extract of wood, and imbibe qualities which are esteemed by some, but which others would wish to avoid: this might perhaps be done by using carbonised casks. To speak generally, the casks which have been thus prepared might possibly be useful at all times when it is wished to preserve liquids from the influence of the extractive part of wood, and even to preserve them from the putrefaction to which they are always liable.

"These prospects are perhaps rather sanguine; and they certainly require the support of experience, to ascertain their real extent and utility."

The observations contained in this letter will serve to direct the execution of this process, in order to obtain the full effect: and chemists will see with pleasure the developement of the idea which the author first communicated in 1803, on the application of the same process to the preservation of wines.

List of Patents for Inventions, &c.

(Continued from Page 376.)

HENRY PRATT, of Birmingham, in the county of Warwick, Steel Toy-maker; for a new toast-stand, or an improvement on the article commonly called cats or dogs, upon which things are placed before a fire. Dated October 2, 1806.

ROBERT SALMON, of Woburn, in the county of Bedford, Surveyor; for newly-invented mathematic-principled, safe and easy trusses, for the relief and cure of ruptures. Dated October 2, 1806.

WILLIAM COOKE, of Chute-House, in the county of Wilts, Gentleman; for certain improvements in the construction of waggons and other carriages with more than two wheels. Dated October 2, 1806.

RALPH WEDGWOOD, of Charles-street, Hampstead-Road, in the county of Middlesex, Gentleman; for an apparatus for producing duplicates of writings, Dated October 7, 1806.

RALPH SUTTON, of Macclesfield, in the county of Chester, Brazier and Tin-plate-worker; for certain improvements in an apparatus for cooking, either by steam or water. Dated October 7, 1806.

WILLIAM SAMPSON, of Liverpool, in the county of Lancaster, Millwright; for a new discovery or invention to be acted on by the impulse of wind, in order to work mills, pumps, and other machinery suitable to its application. Dated October 7, 1806.

ARCHIBALD JONES and JAMES JONES, of Mile End, in the county of Middlesex, Printers; for a method of discharging

charging colours from shawls and other dyed silks and silk and worsted of every description, or such part or parts thereof as may be required, for the purpose of introducing, by printing or staining, various patterns on such discharges or otherwise.
Dated October 7, 1806.

WILLIAM CLEGG GOVER, of Rotherhithe, in the county of Surrey, Carpenter; for an improved wheel or purchase for the steering of ships, by means of which wheel or purchase a considerable degree of labour is saved, and a ship may be steered with more ease, and greater steadiness and certainty, and with more safety to the steerman.
Dated October 15, 1804.

JOSEPH BRAMAH, of Pimlico, in the county of Middlesex, Engineer; for a machine whereby valuable improvements in the art of printing will be obtained.
Dated October 15, 1806.

JOHN FLETCHER, of Cecil-street, in the Strand, in the county of Middlesex, Esq.; for a composition for agricultural purposes, which is not only of the greatest value as a manure, but is also extremely efficacious in the destruction of the fly in turnips, snails, slugs, ants, and the majority of those other insects which are detrimental to vegetables; which composition he usually denominates *Prepared Gypsum*. Dated October 21, 1806.

ELIHU WHITE, of Threadneedle-street, in the city of London, Gentleman; for a method of making a machine for casting or founding types, letters, spaces, and quadrates usually made use of in printing. Communicated to him by a certain foreigner residing abroad.
Dated October 23, 1806.

JOHN PROSSER, of Back-Hill, Hatton-Garden, in the county of Middlesex, Smith; for various improvements upon

upon smoke or air jacks, which may be applied to those now in use. Dated October 30, 1806.

JAMES CAPARN, of Leicester, in the county of Leicester, Brazier; for a machine for discharging smoke from smoking chimnies. Dated October 30, 1806.

ISAAC SANFORD, of the city of Gloucester, Civil Engineer, and STEPHEN PRICE, of the Strand, in the county of Gloucester, Civil Engineer; for a method to raise a nap or pile on woollen, cotton, and all other cloth which may require a nap or pile, as a substitute for teasels or cards. Dated October 30, 1806.

ROBERT BOWMAN, of Leith, Manufacturer; for a method of making hats, caps, and bonnets for men and women of whalebone; harps for harping or cleaning corn or grain, and also the bottoms of sieves and riddles, and girths for horses; and also cloth for webbing, fit for making into hats, caps, &c. and for the backs and seats of chairs, sofas, gigs, and other similar carriages and things; and for the bottoms of beds; as also reeds for weavers, &c. Dated October 30, 1806.

END OF THE NINTH VOLUME, SECOND SERIES.

APPENDIX.

As a part of this month's publication, we have the pleasure of presenting to our readers Earl Stanhope's *scientific work, entitled, "Principles of the Science of Tuning Instruments with Fixed Tones."—We at first thought of composing it anew for our* Repertory; *but, on inspecting it closely, found there would be much difficulty in doing justice to the peculiar nicety of the Tables, as well as danger of not giving them that arithmetical accuracy which they unquestionably possess in coming immediately from the Noble Author's hand; and for these reasons, on adverting to the work being* stereotyped, *we were led to apply to his Lordship for the use of the plates; with which request he readily, and in the most obliging manner, complied. We have no doubt, therefore, that the Treatise will prove most acceptable in its present shape, although it deviates from the common size of our pages.*

Having thus an opportunity of introducing a specimen of Stereotype Printing, *the art itself deservedly merits our attention, on account of its many advantages; of which, however, we shall only at present mention the very desirable one of securing beauty and accuracy to all standard works, whereby the labours of scientific and literary men will be transmitted to posterity,* unsullied *by those* errors *we have had such frequent cause to lament.*

The rudiments of Stereotype have been partially known in this country for many years. The Encyclopædia Britannica, under the article Ged, *says, "The invention, first practised "by Ged in 1735, was simply this: From any types of "Greek or Roman, or any other character, he formed a "plate for every page or sheet of a book, from which he "printed, instead of using a type for every letter, as is done "in the common way." In 1730, Ged, with others that engaged in the business, "applied to the University of Cam-*

" bridge for printing Bibles and Common Prayer-books by " blocks instead of single types; and, in consequence, a lease " was sealed to them April 23, 1731. In their attempt, they " sunk a large sum of money, and finished only two Prayer- " books; so that it was forced to be relinquished, and the " lease given up in 1738."

Subsequent to this period, several ingenious persons, both at home and abroad, have made Stereotype plates; but every effort to give this invaluable art the perfection it required, proved unsuccessful, till the improved process discovered by Earl Stanhope *was adopted, and which is now practised by* Mr. Wilson, *of Duke Street, Lincoln's Inn Fields. We cannot at present detail this process; but the uniform beauty of the works which have already been printed in Stereotype, and the facility obtained in the manufacture of the plates, shew that this most useful art is now firmly established; and, after the repeated failures which it experienced in all former instances, we are bound to say that its present state of superiority is solely attributable to the indefatigable industry of* Earl Stanhope, *who planned the new apparatus and process.*

It also gives us pleasure to announce, that Earl Stanhope *is now engaged in improving several other branches of the printing business, of which we hope at a proper period to give some account. The iron press of the* second *construction, invented by his Lordship, and manufactured by* Mr. Robert Walker, *of Dean Street, Oxford Street, is a most admirable machine, combining neatness with a strong mechanical power, which, at the same time that it lessens very considerably the labour of the pressman, enables him to print with more dispatch, as well as with much greater perfection. This treatise was worked off for us at that press; so that we have the peculiar satisfaction of being thus enabled to exhibit to our readers a faithful specimen of* Earl Stanhope's *two inventions of Stereotype Founding and Stereotype Printing, as now practised by* Mr. Wilson.

PRINCIPLES

PRINCIPLES

OF

THE SCIENCE OF TUNING

INSTRUMENTS WITH FIXED TONES.

SEVERAL of the first mathematicians, as well as many of the most distinguished musicians, have spent much time in endeavouring to discover the best manner of tuning instruments with fixed tones; but their efforts have not, as yet, been attended with the desired success.

When I began this inquiry, I had the curiosity to converse with sixteen or eighteen of the most eminent musicians in England upon this subject. Half of them did then approve of what is called THE EQUAL TEMPERAMENT. This term will be explained hereafter. The other half, on the contrary, reprobated that mode of tuning, as never satisfying the ear perfectly in any one key whatsoever.

A science is evidently in a very imperfect state, when the first proficients in that science not only differ, but even hold decided opinions diametrically opposite to each other. I determined, therefore, to make a careful and methodical investigation, and I can now communicate with particular satisfaction the result to the public.

An ingenious and useful tuning instrument, called a monochord, has long since been invented, by means of which the relation between the lengths of strings or wires which produce different musical sounds can be accurately ascertained.

When a string or wire of uniform thickness is *reduced* in length, it yields a *sharper* sound, provided that the tension of the wire be not altered.

If a string or wire of uniform thickness, stretched on a well constructed monochord, be reduced to one half of its original length; then, that one half will yield the sound of that higher note which is scientifically termed the *perfect octave*, provided that the tension of the wire be not altered. If, for example, the length of an uniform wire be thirty inches, and be so stretched as to yield the same sound as that note, for instance, which is commonly termed the first bass C; then, in order for that same wire, under the same tension, to give the exact sound of the C next above, which is termed the middle C, the length of th

wire must be reduced to fifteen inches. The *perfect octave* is generally called the *octave*, for the sake of conciseness.

If the wire be reduced, not to one half, but to two thirds of its original length, namely, in the supposed case, to twenty inches; then, the sound produced by those two thirds will be that sound which is termed a *perfect fifth*, or a *perfect quint*.

If the wire be reduced to three fourths of its original length, namely, in the supposed case, to twenty two inches and a half; those three fourths will yield the sound which is termed a *perfect fourth*.

And if the wire be reduced to four fifths of its original length, namely, in the supposed case, to twenty four inches; those four fifths will yield the sound which is termed a *perfect third* †.

In like manner, any pitch whatsoever within the compass of the monochord may be obtained, by regulating the length of the wire to the exact degree that is requisite for that purpose.

Having stated precisely what I mean by the expressions *perfect octave*, *perfect quint*, *perfect fourth*, and *perfect third*, I will now shew that there is, in every musical instrument which has exactly twelve fixed keys, or exactly twelve fixed tones, in each septave, a most curious circumstance which is *universal* and *unalterable*. In order clearly to explain what I allude to, let us suppose a keyed instrument, the lowest key of which is C, to have exactly eight C s. Let us also suppose that there be placed, in the same room, a second, and also a third instrument; each of which is similar to the former in every respect, except as to the method of tuning.

Let us suppose that the first instrument be tuned in the following manner. Let us begin by tuning the lowest C to any given pitch. Then let us make all the successive octaves, C C, C C, &c. quite perfect. We shall then have seven successive octaves, which will bring us to the upper C of this instrument.

Now, let us suppose that the second instrument be tuned as follows. Let us begin, as in the former case, by tuning the lowest C; and let us give it precisely the same pitch as the lowest C of the first instrument. Then let us make the

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† Thirds are divided into major thirds and minor thirds. A major third is composed of four intervals, (or four half-tones, as they are commonly called,) and a minor third is composed of three.

There are two species of major thirds; namely, perfect thirds, and imperfect thirds. And the imperfect thirds are also of two species; viz. sharp thirds, and flat thirds.

Example. If, in a tuning instrument which has two wires of equal thickness, the length of some C wire be 300, and if the length of the corresponding E wire, under the same tension, be 240; then, C E will be a *perfect third*. If the E wire be *shorter*, (such as 239,) then C E will be a *sharp third*; that is to say, a third *sharper* than the perfect third. But, if the E wire be longer, (such as 241,) then C E will be a *flat third*; that is to say, a third *flatter* than the perfect third.

The minor thirds are likewise of two species; namely, perfect minor thirds, and imperfect minor thirds. And the imperfect minor thirds are (in like manner as the imperfect major thirds) of two species also; viz. sharp minor thirds, and flat minor thirds.

interval between that C and the G next above a perfect quint. And then, in like manner, let us tune all the following intervals by perfect quints, until we get to C again. We shall then have twelve perfect quints, in the following order, which will bring us to the upper C of this second instrument, viz.

C, G; — G, D; — D, A; — A, E; — E, B; — B, F sharp, which is the same key as G flat†; — G flat, D flat; — D flat, A flat; — A flat, E flat; — E flat, B flat; — B flat, F; — F, C.

Now, let us suppose that the pitch of the upper C in the first instrument be carefully compared with the pitch of the upper C in the second instrument, and it will be found that those two Cs are not *in unison*. For, the upper C in the second instrument, which was pitched by means of the twelve perfect quints, will be found to yield a *more acute* sound than the upper C in the first instrument, which was pitched by means of the seven perfect octaves. Or, in other words, the C twelfth quint in the second instrument will be *sharper* than the C seventh octave in the first instrument.

The difference of pitch between those two high Cs will be rendered far more perceptible to the ear, by transferring that difference to the lower octaves. Therefore, let us suppose that the third instrument be tuned in the following manner, viz. Let us begin by tuning the upper C in this third instrument to the same pitch exactly as the C twelfth quint, or upper C, in the second instrument. And then, beginning from the upper C in this third instrument, let us tune all the other Cs in it successive perfect octaves descending.

Now, if we strike one of the Cs in this third instrument, about the middle octave, or lower down, and if at the same time we strike the corresponding C in the first instrument, then the C in the third instrument, which was derived from the C twelfth quint in the second instrument, will yield a *more acute* sound than the corresponding C in the first instrument which was derived from the octaves. A beating will be heard between them; and a kind of disagreeable sound will be produced, not very unlike the howling of a WOLF at a distance. Now, *the difference of pitch, between the C derived from the quints and the corresponding C derived from the octaves, is what is technically called, by tuners, THE WOLF.*

Musicians and tuners are in the habit of talking of THE WOLF in the singular number. I shall, however, shew in the sequel that there are as many as FIVE WOLVES, in the quints and major thirds taken together, in all those instruments which have exactly twelve fixed keys, or exactly twelve fixed tones, in each septave. Now, in order to distinguish these FIVE from each other, *the difference of pitch, between the C derived from the quints and the corresponding C derived from the octaves,* (which is, by tuners, commonly termed THE WOLF,) *is what I shall call THE QUINT WOLF.* See the following TABLE.

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† Whenever I say that F sharp is the *same key* as G flat, or that G sharp is the *same key* as A flat, &c. I always mean that it is so in a keyed instrument which has exactly twelve fixed keys in each septave.

TABLE OF OCTAVES AND OF QUINTS.

The length of a wire which would yield the same sound as the lowest C, (or fourth bass C,) in the first and second instruments, is represented, in this TABLE, by the number 960.

	Quarters of an inch.	Hundredths of one quarter of an inch, and decimal parts of one hundredth of one quarter of an inch.
ASCENDING PERFECT OCTAVES IN THE FIRST INSTRUMENT. *(Read them from the bottom upwards.)*		
These numbers are found by taking *halves* successively. See page 3.		
7th octave, *or* 3d treble C.	7	50,
6th octave, *or* 2d treble C.	15	
5th octave, *or* 1st treble C.	30	
4th octave, *or* middle C.	60	
3d octave, *or* 1st bass C.	120	
2d octave, *or* 2d bass C.	240	
1st octave, *or* 3d bass C.	480	
Lowest C, *or* 4th bass C.	960	
ASCENDING PERFECT QUINTS IN THE SECOND INSTRUMENT. *(Read them from the bottom upwards.)*		
These numbers are found by taking *two thirds* successively. See page 4.		
12th quint, *or* 3d treble C.	7	39, 905.276.408.858.179.929.692.935 +
11th quint, *or* 2d treble F.	11	09, 857.914.613.287.269.894.494.402 +
10th quint, *or* 1st treble B flat.	16	64, 786.871.919.930.904.841.741.604 +
9th quint, *or* 1st treble E flat.	24	97, 180.307.879.896.357.262.612.406 +
8th quint, *or* middle A flat.	37	45, 770.461.819.844.585.893.918.609 +
7th quint, *or* middle D flat.	56	18, 655.692.729.766.803.840.877.914 +
6th quint, *or* 1st bass G flat.	84	27, 983.539.094.650.205.761.316.872 +
5th quint, *or* 2d bass B.	126	41, 975.308.641.975.308.641. *ad infin.*
4th quint, *or* 2d bass E.	189	62, 962.962. *ad infinitum.*
3d quint, *or* 3d bass A.	284	44, 444.444. *ad infinitum.*
2d quint, *or* 3d bass D.	426	66, 666.666. *ad infinitum.*
1st quint, *or* 4th bass G.	640	
Lowest C, *or* 4th bass C.	960	
DESCENDING PERFECT OCTAVES IN THE THIRD INSTRUMENT, derived from the twelfth quint in the second instrument. *(Read them downwards.)*		
Upper C, *or* 3d treble C.	7	39, 905.276.408.858.179.929.692.935 +
These numbers are found by successive *doubling*. See page 3.		
1st octave, *or* 2d treble C.	14	79, 810.552.817.716.359.859.385.870 +
2d octave, *or* 1st treble C.	29	59, 621.105.635.432.719.718.651.741 +
3d octave, *or* middle C.	59	19, 242.211.270.865.439.437.303.483 +
4th octave, *or* 1st bass C.	118	38, 484.422.541.730.878.874.606.964 +
5th octave, *or* 2d bass C.	236	76, 968.845.083.461.757.749.213.929 +
6th octave, *or* 3d bass C.	473	53, 937.690.166.923.515.498.427.859 +
7th octave, *or* 4th bass C.	947	07, 875.380.333.847.030.996.855.718 +
The *difference of pitch*, between the C derived from the quints and the corresponding C derived from the octaves, is THE QUINT WOLF.		
The length of the wire, for example, which would yield the sound of the first bass C derived from the octaves, is	120	
The length of the wire, which would yield the sound of the corresponding first bass C derived from the quints, is	118	38, 484.422.541.730.878.874.606.964 +
Consequently, *the difference between those two lengths* shews the value of the corresponding QUINT WOLF.	1	61, 515.577.458.969.121.125.393.036 +

There are FOUR OTHER WOLVES in the major thirds. But, in order t explain this part of the subject, it will be necessary first to shew that there ar four series of major thirds which are *unalterably distinct* from each othe Those four series are shewn, in four columns, in the following TABLE O SUCCESSIVE MAJOR THIRDS, where the four keys C, G, D, A, are placed, i the lowest line, in the order of occurrence as successive quints. The other key are then to be placed, as major thirds, in the regular order shewn in the TABLE

TABLE OF SUCCESSIVE MAJOR THIRDS.

(Read each column from the bottom upwards.)

FIRST, or C COLUMN.	SECOND, or G COLUMN.	THIRD, or D COLUMN.	FOURTH, or A COLUMN.	HIGHER OCTAVES of the keys in the first column.
Middle C.	Middle G.	First treble D.	First treble A.	Second treble E.
First bass A flat.	Middle E flat.	Middle B flat.	First treble F.	Second treble C.
First bass E.	First bass B.	Middle G flat.	First treble D flat.	First treble A flat.
First bass C; or key-note.	First bass G.	Middle D.	Middle A.	First treble E.

By inspecting the above simple TABLE, it will clearly appear that th following series of major thirds, viz. C, E; — E, G sharp, which is the sam key as A flat; — and A flat, C, forms a column, in which those three successiv major thirds return in constant and regular succession, without ever including in that series any of the other nine major thirds. So that, nature has, as i were, (if I may be allowed the expression,) *imprisoned* that series of thre major thirds in a column by itself.

The series of the three major thirds, G, B; — B, D sharp, which is the same key as E flat; — and E flat, G, forms a second column.

The series of the three major thirds, D, F sharp, which is the same key as G flat; — G flat, B flat; — and B flat, D, forms a third column.

And, in like manner, the series of the remaining three major thirds, A, C sharp, which is the same key as D flat; — D flat, F; — and F, A, forms a fourth column.

In order to distinguish these four columns from each other, I shall name them from the lowest key in each column respectively; thus, we shall have,

1st, The C column, which consists of C, E, and A flat.
2dly, The G column, which consists of G, B, and E flat.
3dly, The D column, which consists of D, G flat, and B flat.
4thly, The A column, which consists of A, D flat, and F.

Now, it is a very curious fact, that *each* of these four columns of major thirds has ITS OWN DISTINCT WOLF, exclusively of the QUINT WOLF, which, as we have already seen, affects all the twelve keys without exception.

If, in the C column, for example, the three successive major thirds, C, E; — E, G sharp, which is the same key as A flat; — and A flat, C, be all made quite perfect; then, CC, which is thus produced by means of those three perfect thirds, will not be a perfect octave, but it will be *flatter* than the perfect octave CC would be. *The difference of pitch, between the C derived from the major thirds and the C octave corresponding to it, is what I shall call THE C WOLF*†. I shall denominate it thus, because it belongs to the C column. There will be found an exactly similar WOLF in each of the other three columns. These FOUR WOLVES may very properly be distinguished by the names of the four columns to which they respectively belong; thus, we shall have,

1st, In the C column, THE C WOLF.
2dly, In the G column, THE G WOLF.
3dly, In the D column, THE D WOLF.
4thly, In the A column, THE A WOLF.

	Quarters of an inch.	Hundredths of one quarter of an inch.
† If, for example, the length of the wire which would yield the sound of the first bass C be	120	
Then, the lengths of the same wire, under the same tension, which would respectively yield the sounds of the three successive perfect major thirds, would be as follows, viz.		
First bass E.	96	
First bass G sharp, which is the same key as the first bass A flat.	76	80
The middle C which is thus derived from the major thirds.	61	44
(Those numbers are found by taking *four fifths* successively.)		
Now, the length of that wire which would yield the sound of the *true* middle C; namely, the sound of the perfect octave above the first bass C, would be only	60	
Consequently, *the difference between those two last mentioned lengths* shews the value of the corresponding C WOLF.	1	44

And those FOUR, together with THE QUINT WOLF, make the FIVE WOLVES which I have mentioned above. And it was from my having observed these FIVE DISTINCT WOLVES that I was led to find out that superior mode of tuning keyed instruments which I am now going to describe.

If, in any musical instrument which has exactly twelve fixed keys or twelve fixed tones in each septave, the octaves be tuned perfect; then, the quints cannot all be tuned perfect, as the TABLE OF OCTAVES AND OF QUINTS, in page 6, clearly shews. And if, in any such instrument, the quints be tuned perfect; then, the octaves cannot be tuned perfect.

Now, such is the construction of the human ear, that we can bear to hear a *much greater* deviation from perfection in the quints than we can bear to hear in the octaves. And we can bear a *still greater* deviation from perfection in the major thirds than we can bear either in the octaves or in the quints. Musicians and tuners have therefore agreed not to tune all the quints perfect, as that would make the octaves intolerable.

Some tuners, however, in order to assist the quints, have very improperly proposed to tune the octaves a little *imperfect*. The objections to this method are obvious. For, if we sharpen the octaves to assist the quints, it injures the thirds; and if we flatten the octaves to assist the thirds, it injures the quints.

Besides, however small the deviation from perfection may be in a single octave, it will become very sensible in two or three; and, in the extent of six or seven octaves, such a deviation will become very offensive.

It is necessary, therefore, that all the octaves should be tuned *perfect*. Now, from what has been already said, it is evident that this object can be obtained in one way only; and that is, by tuning some one, or more, of the twelve quints above mentioned *flatter than perfect*.

In order for all the octaves to be tuned *perfect*, it is likewise necessary that some one, or more, of the three successive major thirds, in each of the four natural columns above mentioned, must be tuned *sharper than perfect*. As for example, in the C column, some one, or more, of the three successive major thirds, viz. C, E; — E, G sharp, which is the same key as A flat; — and A flat, C, must be tuned *sharper than perfect*; for, otherwise, C C, which is produced by means of those three successive major thirds, could not be (as it ought to be) a perfect octave; because three successive perfect thirds do not make up a perfect octave. Therefore, in tuning any musical instrument which has exactly twelve fixed keys or twelve fixed tones in each septave, the problem does, of necessity, resolve itself into this; namely, to ascertain which one, or more, of the three successive major thirds, in each of the above mentioned four natural columns respectively, ought to be tuned *sharper than perfect*, and in what proportion each is to be so tuned; and also, which one, or more, of the twelve successive quints ought to be tuned *flatter than perfect*, and in what proportion.

What I have just stated will enable the reader easily to understand what musical TEMPERAMENT is. This term signifies *the precise adjustment*

the relative pitch of all the keys or fixed tones of any musical instrument, so as to distribute the four wolves which are in the major thirds, and likewise the quint wolf, according to some given systematic proportions. And the OBJECT OF TEMPERAMENT is to adjust the relative pitch of all the keys or fixed tones in such a due proportion as to render the instrument harmonious and melodious in the highest degree possible. This is an object of very great consequence to the musical world. For, the finest keyed instrument, even if it be played upon in the most capital manner, loses, either when *out of tune*, or when tuned according to an *improper temperament*, the power of producing those delightful and exquisite sensations which the very same instrument becomes capable of producing when it is tuned scientifically and correctly.

There are a great number of different modes of TEMPERAMENT, which may be classed as follows, viz. the EQUAL TEMPERAMENT, and the UNEQUAL TEMPERAMENTS.

That mode of temperament in which the quint wolf is distributed in an equal proportion amongst all the twelve quints of an instrument is that which is called THE EQUAL TEMPERAMENT. And every other mode of temperament, without exception, is called an UNEQUAL TEMPERAMENT.

In that mode of tuning which is called THE EQUAL TEMPERAMENT, all the twelve quints are made imperfect; for, every one of them is tuned *flatter than perfect*. But, in my mode of tuning, for example, which is one of the UNEQUAL TEMPERAMENTS, there are, as will be explained in the sequel, seven quints quite *perfect*, and five quints *flatter than perfect*.

The consequence of an equal distribution of the QUINT WOLF, in THE EQUAL TEMPERAMENT, is, that the C WOLF will become, of necessity, equally distributed amongst the three major thirds in the C column; and that the G, D, and A WOLVES will become equally distributed amongst the three major thirds in the G, D, and A columns respectively.

THE EQUAL TEMPERAMENT is, however, a mode of tuning which I very much disapprove. According to that erroneous system, there is not a single *perfect* third, nor a single *perfect* fourth, nor a single *perfect* quint, in the whole instrument. That charming and delightful harmony and melody which a proper mode of tuning enables fine players to produce, is thus rendered, in every case, impossible. All those chords, which nature has rendered perfect, are, by this objectionable contrivance, rendered imperfect. And in those instruments where chords are made to sound for a considerable time, such for instance as organs, the imperfection of THE EQUAL TEMPERAMENT is most striking. Perfect chords are pleasing to the ear, they strike to the heart, and they are founded in the very nature of musical sounds. But, by that mode of tuning which is called THE EQUAL TEMPERAMENT, all those regular coincidencies of those duly proportioned vibrations which produce true concords are destroyed, and every thing is discord. Let us take a quint, as an example explanatory of this fact. We have already seen, that, when the wire in a well constructed monochord is

reduced to two thirds of its length, the sound produced by the two thirds will be that of a perfect quint. Now, the number of vibrations of a wire of uniform thickness, which has any given degree of tension, will be *inversely* as the length of the wire. That is to say, that a wire, for example, of thirty inches long, will vibrate twice, during the time that an equal wire, of twenty inches long, under the same tension, will vibrate three times. If the longer wire be tuned to C, the shorter wire will be the G perfect quint. It follows from this, that the *third, sixth*, and *ninth* vibrations, &c. of the G wire so tuned, will respectively keep pace with the *second, fourth*, and *sixth* vibrations, &c. of the C wire above mentioned. And it is from that very circumstance that concords are produced. But, let us suppose, that the length of the G wire, instead of being precisely two thirds of the length of the C wire, be either something more, or something less; then, the *third, sixth*, and *ninth* vibrations, &c. of the G wire, will no longer respectively keep pace with the *second, fourth*, and *sixth* vibrations, &c. of the C wire. Therefore, instead of concords, discords will be heard. For, true concords can only be obtained by means of exact geometrical proportions between the vibrations produced. —— There are various classes of discords. Some of them are offensive; others are not. Some of them are characteristic; others are not so. How to limit the extent of the discordancies, and how to distribute the non-offensive discords in such a manner that the various keys, instead of being injured, shall on the contrary be improved, will be very fully explained hereafter. But, to have, in any instrument, nothing but discords, is abominable; and that is always and necessarily the case, whenever that mode of tuning which is denominated THE EQUAL TEMPERAMENT is adopted.

By the scheme of EQUAL TEMPERAMENT, not only every third is sharp, but is equally sharp; every fourth is sharp, and is also equally sharp; and every quint is flat, and is equally flat. Therefore, not only every major key is rendered imperfect, but is rendered similarly and equally imperfect. This of course destroys *the difference of character* which ought to exist, in a well tuned instrument, between the different major keys. And the minor keys are liable to the same defect, for a similar reason. Thus it is that dull monotony is substituted for pleasing and orderly variety. And modulation from key to key loses, in great measure, the very object of modulation, which is to relieve the ear, and to cause us to return to the original key with an increased pleasure, which arises from the systematic variety of the different keys through which we have successively passed.

Some tuners, who prefer an UNEQUAL TEMPERAMENT, throw the whole of the QUINT WOLF into the key of E flat. Others, divide it between the two keys of A flat, and D flat; or between some other two keys. Those persons generally say, that they throw THE WOLF (as they inaccurately call it) into a single key, or into two keys, according to their respective method of tuning. The absurdity of this assertion must now be apparent to the reader. For, since there is not only in the quints a QUINT WOLF, but there are likewise in the major thirds FOUR DISTINCT WOLVES, each of which four is by nature confin

to *its own peculiar and unalterable column;* it is obvious that the D WOLF, for instance, cannot ever be taken from its own column, to be carried, either to the key of E flat, in the G column; or to the key of A flat, in the C column; or to the key of D flat, in the A column. Such temperaments are, therefore, unsatisfactory in theory. They are also defective in practice; for, they render some keys too bad to modulate into them without offending the ear extremely.

In my new method, there are none of those defects. Every key in my TEMPERAMENT is made pleasing, and fit for transposition and modulation, and has also a *peculiar character* which belongs to it. Some keys are fitted for chearful music; some, for grave. Some, for martial; some, for pastoral. Some, for soft or melodious pieces; and some, for those which are solemn, plaintive, or majestic. How is it possible that the same key, or twelve keys of exactly the same character, should be capable of giving to compositions of directly opposite characters, that effect which is the best suited to each composition respectively?

In order to introduce the greatest degree of variety which is consistent with proper harmony and with proper melody, it is evident that some one key, at least, should be made as *perfect* as possible. If so, the key of C, which so frequently recurs, ought to be that key. It is besides the only key which has neither flats nor sharps in the common construction of keyed instruments.

I, therefore, make the key of C, with a perfect third, C, E; with a perfect fourth, C, F; and with a perfect quint, C, G. —— In tuning, I proceed thus.

First. I begin by pitching the first bass C, to my tuning-fork, tuning-glass, or monochord. I consider the first bass C as the key-note. I then make the next C above, which is called the middle C, a perfect octave from the first bass C.

Or, I pitch the middle C, to my tuning-fork, tuning-glass, or monochord; and I then pitch the first bass C, as a perfect octave next below. It is of no consequence which of those two equivalent methods be used to obtain the pitch of those two Cs. But, in order to tune the other keys of the instrument, I prefer starting from the first bass C, as the key-note; instead of starting from the middle C; because the beatings are more perceptible to the ear, in the former case, than they would be in the latter. —— The reader will do well to turn to the TUNING TABLE, in page 15, and to follow it in reading the pages 12, 13, and 14.

Secondly. From the first bass C, I make C, G, a perfect quint.

Thirdly. From the first bass C, I make C, E, a perfect third. And I then tune the two octave Es next above.

Fourthly. From E, I make E, B, a perfect quint; and I prove B, from G, as a perfect third.

Fifthly. From the middle C, I tune C, F, upwards, a perfect fourth; or (what is equivalent) I tune F, C, downwards, a perfect quint. I then tune the F next above, a perfect octave.

Sixthly. The pitch of F being determined, I tune F, B flat, upwards, a perfect fourth; or (what is equivalent) B flat, F, downwards, a perfect quint.

Seventhly. I then pitch A flat, exactly half way between E and the C next above. If a monochord be used for this purpose, the length of the wire A flat must be made *a geometrical mean proportional* between the length of the wire E and the length of the wire C next above. The two sharp thirds produced by this method are peculiarly suited to solemn and to plaintive music. The effect was remarkably striking, in a comparative experiment which I shall relate in the sequel. I was so struck with the peculiar excellency of sharp thirds of this exact value for musical compositions which are either plaintive or majestic, that I have, for the sake of accuracy and methodical discrimination, given them a distinct name. *If, from any perfect octave, we deduct one perfect third; and if we then divide the remaining interval into two thirds equally sharp; each of those two thirds, as well as every other third of that same degree of sharpness, is that sharp third which I shall call a BI-EQUAL THIRD.*

If the pitch of A flat be not determined by means of a monochord, but simply by the ear, its pitch may be ascertained with great precision, if the tuner pay exact attention to the equality of the beatings of the two successive major thirds, E, G sharp, which is the same key as A flat; and A flat, C. —— In tuning each key throughout the whole instrument, too much attention cannot be paid to the beatings, as that is by far the most accurate way of tuning by the ear. For, whenever either a third, a fourth, a quint, or an octave is quite *perfect*, there is, in such case, no beating to be heard. But, on the contrary, whenever either of them is in any degree *imperfect*, but is not too distant from perfection, a beating is always audible. —— A very slow beating proves that the deviation from perfection is not great. A quicker beating shews that the deviation from perfection is more considerable. And, from the equality of the beatings, equal deviations from perfection may be correctly ascertained.

Eighthly. The pitch of A flat being now determined, I next pitch A flat, E flat, upwards, a perfect quint; or I tune E flat, A flat, downwards, a perfect fourth. E flat will then be exactly half way between B and the G next above.

Ninthly. The pitch of A flat being determined, as explained above; I tune A flat, D flat, upwards, a perfect fourth; or I tune D flat, A flat, downwards, a perfect quint. I then tune the D flat next above, a perfect octave.

Tenthly. The pitch of D flat being determined, I tune D flat, G flat, upwards, a perfect fourth; or I tune G flat, D flat, downwards, a perfect quint.

Thus, I have already got seven quints quite *perfect;* viz. 1. C, G; 2. E, B; 3. F, C; 4. B flat, F; 5. A flat, E flat; 6. D flat, A flat; 7. G flat, D flat.

I have likewise got two quints very nearly perfect, but a little flat, viz. 1. B, F sharp, which is the same key as G flat; 2. E flat, B flat.

Each of those two quints differs from a perfect quint, only ONE in *two thousand six hundred and fifty seven parts and a half* nearly; or only about 1.128.831 parts in 3.000.000.000. See the value of those two quints, in page 23.

It is a fact very worthy of notice, that, in each of those two last mentioned quints, *two distinct beatings* are to be heard at the same time. The one is ver-

slow, and the other is considerably quicker. Now, as each of these two quints does, as proved by the monochord, approach so very nearly to perfection; it is evident, that it is the *slower* beating which is the proper beating to be attended to in the case of each of those two quints which are so very nearly perfect.

I have a scientific way of determining the three remaining quints that are also flat, which I shall now explain. They are, 1. G, D; 2. D, A; 3. A, E.

We have already seen that the pitch of G has been determined, as a perfect quint from the first bass C. The pitch of E has likewise been determined, as a perfect third from that same C. The E first octave above from that E, and the E second octave above from that same E, are of course determined likewise.

Eleventhly and twelfthly. It is now requisite so to pitch the D, and the A, between the G perfect quint from C, and the E second octave from that E which is the perfect third from C, in such a manner, that the interval G, E, may be divided into three equally flat quints, G, D; D, A; and A, E. None of those three quints are of such a degree of flatness as to be offensive to the ear; for, each of those three quints differs from a perfect quint, only ONE in *three hundred and sixty one parts and a half* nearly; or only about 8.298.850 parts in 3.000.000.000. See the value of those three quints, in page 23. —— If a monochord be used to determine the pitch of D, and of A; then, the length of the wire D, and the length of the wire A, must be made *two geometrical mean proportionals*, between the length of the wire G, and the length of the wire E. But, if a monochord be not used for this purpose, and if the tuner determine the pitch of D, and of A, by the ear; it may be done with great accuracy, if he attend properly to the equality of the beatings of the three successive flat quints, G, D; D, A; and A, E. That fact has been ascertained by repeated trials.

If the interval G, E, be (as in Kirnberger's method of tuning) divided into one perfect quint, and two equally flat quints; such, for instance, as the perfect quint G, D, and two equally flat quints, D, A, and A, E; then, each of those two flat quints, by becoming too flat, is offensive to the ear. I have made that experiment with care; and the result was what I have just mentioned. And if the same interval G, E, be divided into two perfect quints, and one flat quint; then, the flat quint, so produced, is still more offensive. This was fully to be expected.

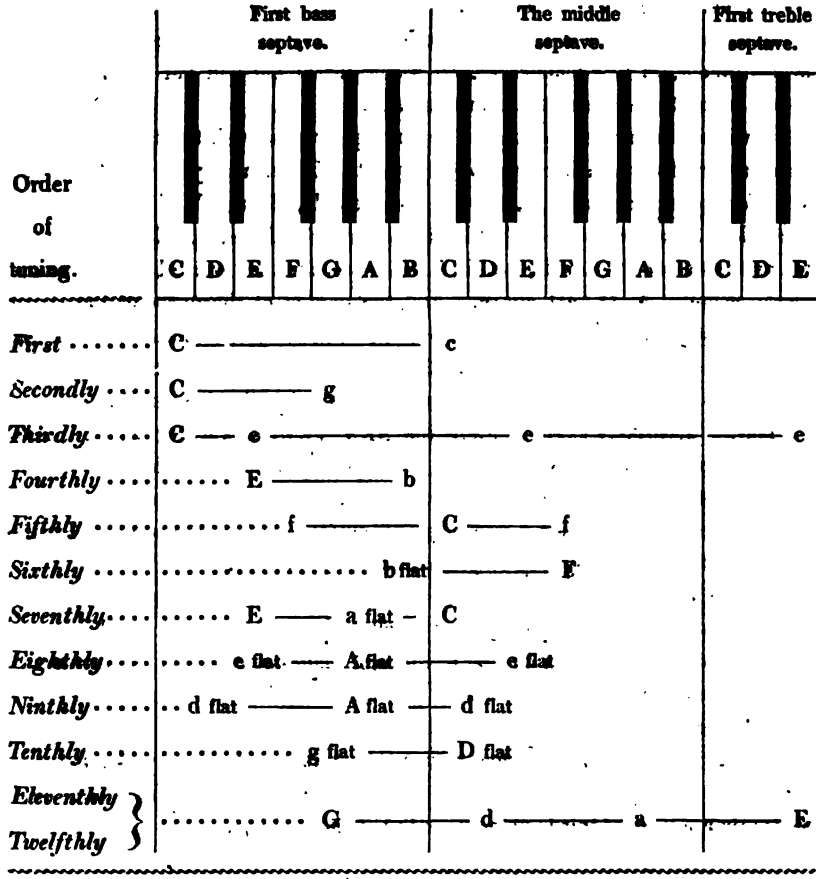
I shall now give a definition of those three equal and non-offensive quints which result from the scientific division of the interval G, E, above explained, in order clearly to distinguish it from the two exceptionable divisions just described. That is to say; *if the interval between the perfect quint from a key-note, and the second perfect octave above the perfect third from the same key-note, be divided into three equally flat quints; each of those three equal quints is that which I shall call a TRI-EQUAL QUINT. And the inverse fourth of any tri-equal quint is that which I shall call a TRI-EQUAL FOURTH.*

My NEW MODE OF TUNING, which I have just minutely explained, is exhibited in a very convenient manner in the following TABLE.

TUNING TABLE;

Shewing, at one view, the MANNER and ORDER of tuning the twelve keys of an instrument, according to the STANHOPE TEMPERAMENT.

As soon as a key is tuned, it is represented by a CAPITAL LETTER.
The small letters *represent those keys which are going to be tuned.*


First bass septave.
The middle septave.
First treble septave.
Order of tuning.
C D E F G A B C D E F G A B C D E
First ..... C — c
Secondly .... C — g
Thirdly ..... C — e — e — e
Fourthly .... E — b
Fifthly ..... f — C — f
Sixthly ..... b flat — F
Seventhly .... E — a flat — C
Eighthly .... e flat — A flat — e flat
Ninthly ..... d flat — A flat — d flat
Tenthly ..... g flat — D flat
Eleventhly
Twelfthly
G — d — a — E

First ..... C, c, perfect octave.
Secondly ..... C, g, perfect quint.
Thirdly ..... C, e, perfect third. And e, e; — e, e, two perfect octaves.
Fourthly ..... E, b, perfect quint.
Fifthly ..... f, C, perfect quint. And f, f, perfect octave.
Sixthly ..... b flat, F, perfect quint.
Seventhly ..... E, a flat; — a flat, C, two bi-equal thirds. See page 13.
Eighthly ..... A flat, e flat, perfect quint.
Ninthly ..... d flat, A flat, perfect quint. And d flat, d flat, perfect octave.
Tenthly ..... g flat, D flat, perfect quint.
Eleventhly and twelfthly ... G, d; — d, a; — a, E, three tri-equal quints. See page 14.

After I have tuned, in the manner above particularly specified, those septaves which are about the middle of the instrument; I then tune all the octaves perfect, both in the upper and in the lower septaves. If it be a piano-forte, or any other instrument which has two or more strings to each key; then, great attention should be paid to the tuning of those unisons perfect.

When the instrument is tuned, according to the rules above mentioned; the octaves should be tried as follows. Strike four Cs at once all through the instrument. Then four Ds, &c. successively. Try the short keys all through the instrument, in like manner. And if the instrument will not stand this test, we may be quite certain that it is *not in tune*.

It will not be necessary for me to go regularly through the twelve fourths; as they always follow their corresponding quints. Thus, a *perfect quint*, such as the perfect quint, for example, from B flat, namely, B flat, F, will give, for the inverse key F, a *perfect fourth*, viz. F, B flat next above. And a *flat quint*, such as the flat quint from D, viz. D, A, will give, for the inverse key A, a *sharp fourth*, namely, A, D next above. And the degree of sharpness of the sharp fourth will always, of necessity, correspond with the degree of flatness of the flat quint, wherever a flat quint occurs. My mode of tuning does not produce a single offensive quint; neither does it produce a single offensive fourth.

Having accurately explained how the NEW TEMPERAMENT which I have discovered regulates the twelve quints, and also the twelve fourths; I will now shew in what manner it affects the twelve thirds. But, before I can make myself clearly understood upon this interesting and curious part of the subject, I must first state a few things, by way of preliminary observations.

I have established the following facts, from experiments made with the greatest attention, by means of a very excellent monochord, and also by means of a grand piano-forte, built by one of the best piano-forte makers in England.

I divided the perfect octave CC, between the first bass C and the middle C, into three successive thirds, in the three following ways, viz.

First. I divided that perfect octave CC, into two perfect thirds, namely, C, E; and E, G sharp, which is the same key as A flat; and into one third sharper than a perfect third, namely, A flat, C next above. This sharper third, so produced, was, as I expected, very offensive.

Secondly. I divided that same perfect octave CC, into one perfect third, C, E; and into two equally sharp thirds, viz. E, G sharp, which is the same key as A flat; and A flat, C next above. The length of the wire A flat, in the monochord, was made *a geometrical mean proportional* between the length of the wire E, and the length of the wire C next above. This last mentioned division of the octave CC is excellent; for, the two sharp thirds thus produced were *bi-equal thirds*, as was particularly explained above. See page 13.

Thirdly. I then divided the same perfect octave CC, into three thirds, all equally sharper than perfect. This equal division was effected, by the wires E, and A flat, in the monochord, having been made *two geometrical mean*

proportionals between the length of the wire C, and the length of the wire C next above. Those three equally sharp thirds, of this last mentioned value, are the very same as the sharp thirds which result from that mode of tuning which is commonly termed THE EQUAL TEMPERAMENT. Not one of those three equally sharp thirds has either of those two striking characters which are to be found in an instrument that is tuned in the most advantageous manner. For, not one of those three equally sharp thirds has either the beauty of a third which is *perfect*, nor the peculiar and solemn character of that other third which I have already denominated a *bi-equal third*. This is, therefore, another inherent defect belonging to that method which is called THE EQUAL TEMPERAMENT; inasmuch as that defect necessarily extends to all the twelve keys, in that ill contrived mode of tuning.

I can now explain to the reader in what manner the NEW TEMPERAMENT which I have discovered affects the twelve thirds, in a keyed instrument which has exactly twelve † keys in each septave.

Two of those twelve thirds are quite perfect. Those two are, 1. C, E; 2. G, B.

Six of the remaining ten thirds are sharper than perfect; and each of them is of the exact value of a *bi-equal third*. Those six are, 1. E, G sharp, which is the same key as A flat; 2. A flat, C; 3. B, D sharp, which is the same key as E flat; 4. E flat, G; 5. G flat, B flat; 6. D flat, F.

The remaining four thirds are likewise sharp, but less so than the preceding six; and each of them is, in respect to sharpness, *intermediate* between the other two classes above specified; namely, *intermediate* between a perfect third and a bi-equal third. See page 23.

Of those four last mentioned sharp thirds, two are nearer to a bi-equal third than to a perfect third. Those two are, 1. A, C sharp, which is the same key as D flat; 2. B flat, D. See page 23.

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† The usual number of *twelve keys* seems to be pointed out to us from the natural number of *twelve musical intervals*. —— There are three reasons for considering that division of the septave as a *natural* one.

First. If we start from any key, (such, for example, as from C,) then, *twelve* quints, duly tempered according to my natural and scientific TEMPERAMENT explained above, will bring us again to a key of the same denomination. Therefore, the number of *twelve* successive quints naturally leads to the number of *twelve keys* of *twelve* distinct denominations.

Secondly. There are four natural sets or columns of major thirds, and each of those four sets respectively contains three series of major thirds, as was fully explained above. See pages 7 and 8. This makes up the same number of *twelve keys*.

Thirdly. The like number of *twelve keys* is found also in the following manner; namely, by considering the three natural sets or columns of minor thirds; for, each of those three sets respectively contains four series of minor thirds, making likewise *twelve keys* in all, viz.

First set. 1. C, E flat; 2. E flat, G flat; 3. G flat, A; 4. A, C.
Second set. 1. D flat, E; 2. E, G; 3. G, B flat; 4. B flat, D flat.
Third set. 1. D, F; 2. F, A flat; 3. A flat, B; 4. B, D.

And, of the four *intermediate* sharp thirds above mentioned, the remaining two are nearer to a perfect third than to a bi-equal. Those two last mentioned thirds are, 1. D, F sharp, which is the same key as G flat; 2. F, A. See page 23.

The reader will therefore perceive, that, in my TEMPERAMENT, the most easy keys have, for thirds of the key, those thirds which are the most perfect.

The two thirds of the key which are quite perfect are in the following keys, viz.

C major, which is without either flat or sharp;
G major, which has only one sharp.

The two sharper thirds of the key which are the nearest being perfect are in the following keys, viz.

D major, which has only two sharps;
F major, which has only one flat.

The two still sharper thirds of the key which come next in respect to sharpness are in the following keys, viz.

A major, which has three sharps;
B flat major, which has two flats.

And those six sharpest thirds of the key, each of which I term a *bi-equal third*, are in the following keys, viz.

E major, which has four sharps;
B major, which has five sharps;
E flat major, which has three flats;
A flat major, which has four flats;
D flat major, which has five flats;
G flat major†, which has six flats.

As there is not, in my TEMPERAMENT, any third, any fourth, or any quint, less perfect than those specified above and in the following TABLES; it is evident that this new mode of tuning must be excellent for transposition, and for modulation. This fact has been established by regular and repeated experiments, made in presence of many of the best judges. Between sixty and seventy of the very first professional persons, of both sexes, and of the ablest connoisseurs in England, have given to this NEW TEMPERAMENT their decided approbation. It answers well, both in the major and in the minor keys.

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† Some authors call the key of G flat major, the key of F sharp major with six sharps. But it is more systematic and methodical, to consider (as Dussek does) the five short keys as flat keys in the major mode.

There are some few facts, in particular, which throw such light upon the science of music, that I think it proper to mention them. On an excellent piano-forte, tuned in my manner, that favourite portuguese hymn, called *Adeste Fideles*, which is commonly printed in A major, was played successively in that key, in the key of A flat major, in C major, and in D flat major. The following was the result of this comparison.

First, the piece was the most characteristic and sublime in the key of A flat. It was better in that key even than in the original key of A.

Secondly, the hymn was comparatively intolerable in the key of C; although, according to my TEMPERAMENT, the key of C is tuned *perfect;* having a perfect third, a perfect fourth, and likewise a perfect quint.

Thirdly, the piece was better even in the key of D flat than in the key of C; although the pitch of the key of D flat (being higher up) is less suited to the character of that solemn composition than the pitch of the key of C.

That is to say, in other words, that the intermediate key of C, although it be tuned *perfect*, is less proper for that piece of music than either D flat or A flat; one of which has a higher, and the other a lower pitch. And this fact is the more remarkable, on account of the following illustrative circumstance. Each of those three major keys, namely, D flat, C, and A flat, has, according to my TEMPERAMENT, a perfect fourth, and a perfect quint. Therefore, it is evident that the difference in the effect produced could result neither from the respective fourths, nor from the respective quints.

Consequently, the striking differenee between those three keys, which every person with a good ear must feel, results principally from the thirds, and from the sixths, in each key respectively. And those two keys, namely, D flat, and A flat, *where the third in each is imperfect, and is of the exact value of a bi-equal third*, are beyond comparison better suited to the solemn character of the hymn than the key of C, where the third is, on the contrary, tuned quite *perfect*.

We have been in the habit of considering what is commonly termed THE WOLF as an inherent imperfection in every instrument which has exactly twelve fixed keys in each septave. Whereas, the very remarkable fact just mentioned, and several others of a like kind, most clearly prove, that, so far from THE FIVE WOLVES being imperfections, it is precisely the proper distribution of those WOLVES which produces that charming and essential VARIETY OF CHARACTER, between the different keys, which is one of the chief requisites in a well tuned instrument.

Thus it is, that, from our ignorance and narrow prejudices, the *perfection* of the principles which are to be found in nature are by us very frequently unobserved. But the more thoroughly we learn to understand them, the more we ought to feel gratitude towards the SUPREME BEING for enabling us to perceive the *sublime excellence* of their wonderful arrangement.

TABLE OF ALL THE KEYS IN AN OCTAVE;

Shewing the systematic and characteristic VARIETY which is produced between them by means of the STANHOPE TEMPERAMENT.

KEYS.	THIRDS.	FOURTHS.	QUINTS.
C.	Perfect.	Perfect.	Perfect.
B.	Bi-equal third.	Perfect.	Very nearly perfect.
B flat.	Intermediate between perfect and bi-equal third, but nearer to bi-equal.	Very nearly perfect.	Perfect.
A.	Intermediate between perfect and bi-equal third, but nearer to bi-equal.	Tri-equal fourth.	Tri-equal quint.
A flat.	Bi-equal third.	Perfect.	Perfect.
G.	Perfect.	Perfect.	Tri-equal quint.
G flat.	Bi-equal third.	Very nearly perfect.	Perfect.
F.	Intermediate between perfect and bi-equal third, but nearer to perfect.	Perfect.	Perfect.
E.	Bi-equal third.	Tri-equal fourth.	Perfect.
E flat.	Bi-equal third.	Perfect.	Very nearly perfect.
D.	Intermediate between perfect and bi-equal third, but nearer to perfect.	Tri-equal fourth.	Tri-equal quint.
D flat.	Bi-equal third.	Perfect.	Perfect.
C.	Perfect.	Perfect.	Perfect.

N. B. Of the six keys which have, for the sharp third, a bi-equal third, four have quints *quite perfect*, and two have quints *very nearly perfect*.

The three tri-equal quints have thirds of *different* values, and so have likewise the three tri-equal fourths.

MONOCHORD TABLE,

No. I.

Shewing the length of each wire, from the middle C, to the C next below, both inclusive; supposing that the wire which yields the sound of the last mentioned C be 120 quarters of an inch long between the two bridges of the monochord.

Keys.	Quarters of an inch.	Hundredths of one quarter of an inch, and decimal parts of one hundredth of one quarter of an inch.
Middle C.	60	
First bass B.	64	
B flat.	67	50,
A.	71	70, 247.592 +
A flat.	75	89, 466.384 +
G.	80	
G flat.	85	38, 149.682 +
F.	90	
E.	96	
E flat.	101	19, 288.512 +
D.	107	10, 927.200 +
D flat.	113	84, 199.576 +
C.	120	

MONOCHORD TABLE,

No. II.

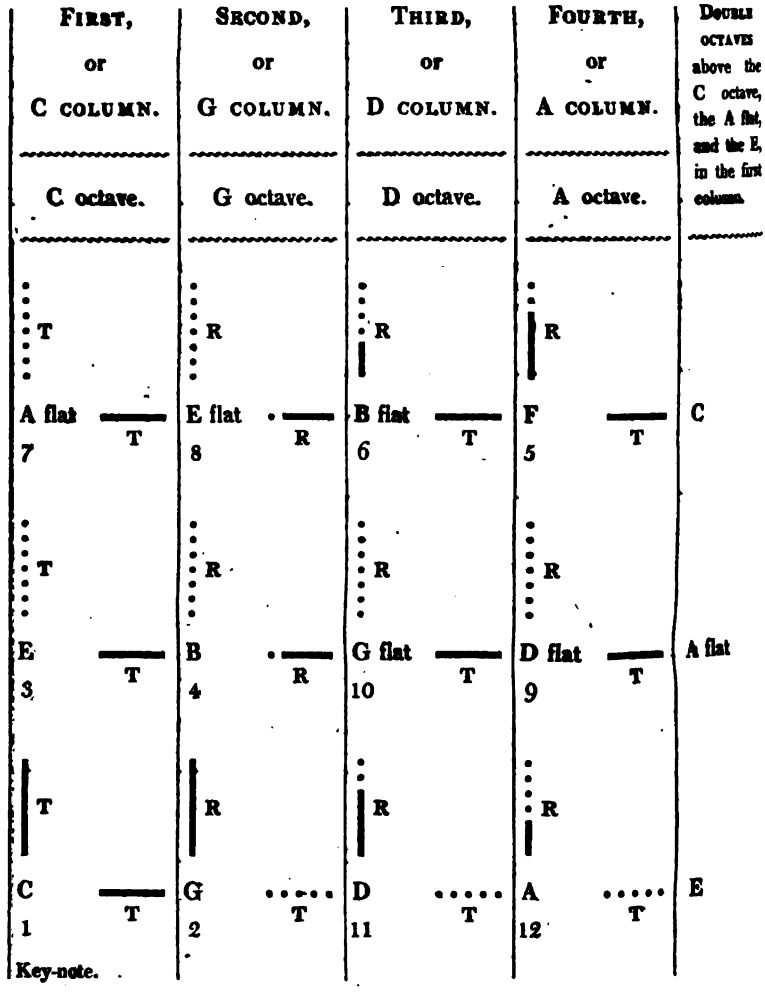
Shewing the manner of setting off the whole monochord scale, *from a single point;* supposing that point to be the extremity of the length of the G wire.

N. B. *This mode of setting off the scale, on the steel rod, is more mechanically accurate than setting it off from more points than one.*

Keys.	Quarters of an inch.	Hundredths of one quarter of an inch, and decimal parts of one hundredth of one quarter of an inch.	
Middle C.	20		To be set off BACKWARDS.
First bass B.	16		
B flat.	12	50,	
A.	8	29, 752.407 +	
A flat.	4	10, 533.615 +	
G.	0		
G flat.	5	38, 149.682 +	To be set off FORWARDS.
F.	10		
E.	16		
E flat.	21	19, 288.512 +	
D.	27	10, 927.200 +	
D flat.	33	84, 199.576 +	
C.	40		

MUSICAL MEMORANDUM TABLE;

Shewing, at one view, the MANNER in which the THREE KEYS, in each of the FOUR NATURAL COLUMNS respectively, are affected by the STANHOPE TEMPERAMENT.



The FIGURES *under* the letters shew the ORDER in which the keys ought to be tuned.

The thirteen Ts are those intervals which are actually TUNED.

The eleven Rs are those intervals which are not actually tuned, but which RESULT from those intervals which are actually tuned.

EXPLANATION OF THE MUSICAL MEMORANDUM TABLE;

With the value of the THIRDS *and* QUINTS *reduced to a common denominator.*

EXPLANATION OF THE MARKS *OVER* THE LETTERS.	Relative lengths of the wires.	Difference between those lengths.
Means a perfect third.	2.400.000.000 / 3.000.000.000	600.000.000 / 3.000.000.000
Means a sharp third which is intermediate between perfect and bi-equal, but nearer to perfect.	D, G flat, = 2.391.431.532 + / 3.000.000.000	608.568.467 + / 3.000.000.000
	F, A, = 2.390.082.530 + / 3.000.000.000	609.917.469 + / 3.000.000.000
Means a sharp third which is intermediate between perfect and bi-equal, but nearer to bi-equal.	A, D flat, = 2.381.549.471 + / 3.000.000.000	618.450.528 + / 3.000.000.000
	B flat, D, = 2.380.206.044 + / 3.000.000.000	619.793.955 + / 3.000.000.000
Means that sharp third which is called a bi-equal third.	2.371.708.245 + / 3.000.000.000	628.291.754 + / 3.000.000.000

EXPLANATION OF THE MARKS *AFTER* THE LETTERS.	Relative lengths of the wires.	Difference between those lengths.
—— Means a perfect quint.	2.000.000.000 / 3.000.000.000	1.000.000.000 / 3.000.000.000
• —— Means a flat quint which is very nearly perfect.	2.001.128.831 + / 3.000.000.000	998.871.168 + / 3.000.000.000
••••• Means that flat quint which is called a tri-equal quint.	2.008.298.850 + / 3.000.000.000	991.701.149 + / 3.000.000.000

N. B. The ten Ts to the *quints* shew that ALL the quints are TUNED; except the two quints, B, G flat; and E flat, B flat, marked thus • ——

The three Ts to the *thirds* shew that ALL the three successive thirds in the C column are TUNED.

And the two Rs to the *quints*, and the nine Rs to the *thirds*, shew that ALL the other quints and thirds RESULT from the *tuned* intervals.

PARTICULARITIES OF THE STANHOPE MONOCHORD.

First. The wire is not made either of brass or of iron, but of steel, which is very far superior. For, steel wire does not keep continually lengthening, as brass and iron wires do when they are stretched considerably.

Secondly. The wire in this monochord does not, as usual, pull downwards on the bridges, but the whole wire forms one straight and horizontal line, by which means the moveable bridge, which determines the exact length of the wire, can be moved without altering the tension of the wire. This is not the case when the wire pulls downwards on the bridges.

Thirdly. The ends of the wire are not twisted round the two stout steel pins which keep it stretched; but, each end of the wire is soft-soldered in a long groove formed in a piece of steel which goes over its corresponding pin. This is a great improvement.

Fourthly. One of those two steel pins is strongly fastened on a brass slider which is moved by means of a screw with very fine threads, which screw has a large micrometer head minutely divided on its edge, and a corresponding *nonius;* so that, the tension of the wire may be adjusted with the greatest precision, in order to obtain its exact pitch.

Fifthly. A slider is fixed across the top of the moveable bridge, and is moved by means of another screw with very fine threads; so that, the length of the wire may be regulated with the greatest nicety in all cases.

Sixthly. The above mentioned slider which is on the top of the moveable bridge is adjusted to the steel rod or scale, not by sight, or by the coincidence of lines; but by means of *mechanical contact* against projecting pieces of steel firmly fixed on that steel scale, which method is incomparably more correct. Those projecting pieces are fixed on that scale at the respective distances specified in the MONOCHORD TABLE, NO. I. See page 21.

Seventhly. Each bridge carries a metallic finger which keeps the wire close to the top of the bridge whilst the wire is made to vibrate.

Eighthly. The vibrations of the wire are produced by touching it with a piece of cork, with the same elastic force, and on the very same spot each time, namely, at the distance of one inch from the immoveable bridge.

A MOST CURIOUS AND IMPORTANT EXPERIMENT.

There is a second steel wire, equal in size, which may be placed occasionally on this monochord. The reader may form an idea of the prodigious accuracy of this instrument, from the following experiment, which I have often repeated in the presence of different persons, to the great astonishment of them all.

I begin by stretching the two wires with a degree of tension so precisely equal, that no beating is audible between them. In this experiment, I have generally made the length of each wire exactly twenty inches between the bridges; and each wire has been so stretched as to yield the same sound as that note which is commonly called the first bass G; but any other note would do.

By means of a fine screw, which has fifty threads to the inch, and which has a micrometer head very finely divided on its edge, I can move the slider on one of the bridges to such a minute degree, as to lengthen or shorten that wire as little as *the one hundred and eightieth part of the one hundredth of an inch*, without altering its tension. Such a very small alteration in the length of one of the two wires invariably produces an audible beating between them. And not only the beating may be *heard;* but, what is remarkable, it may likewise be distinctly *felt*. The best way to feel it, is to support a small piece of steel wire, about two inches long, on the soundboard of the monochord, with one of the finger nails. If the lower end of that piece of wire be semi-spherical; if its upper end be pointed; and if that pointed end be applied to the new or tender part of the nail; then, the beating will be *felt* very sensibly.

This beautiful experiment clearly proves how perfectly *unisons* may be tuned; since, *the smallest deviation in an unison* is thus distinctly perceptible. This leads me to my next discovery.

STANHOPE TUNING-GLASSES.

Some persons have had tuning-forks adapted to the pitch of the different notes. One fork, to the pitch of C; another, to the pitch of G, &c. The tuner has then nothing to do but to tune all the Cs of the piano-forte, organ, or other keyed instrument, to the C fork; all the Gs to the G fork, &c. This is perfectly good in theory. But there is, in practice, an objection to forks which is not generally known. It is this. Out of a hundred forks, there is, perhaps, not one which has not a beating in it, when it is struck. How, then, is it possible to tune an instrument accurately by means of forks which do not yield a pure or single sound? It is, however, frequently practicable to get rid of the beating in a tuning-fork, by very carefully filing the two legs so as to make them exactly alike throughout. But, this requires much more attention than is likely to be commonly bestowed.

I have contrived a tuning instrument which is far superior. It consists of thirteen slips of plate-glass; each of which is exactly six inches long, by two inches in breadth. They are tuned respectively one perfect octave higher than the pitch of the keys in the MONOCHORD TABLE, NO. I. For, by varying the thickness, I can tune one slip to C; another, to G, &c. The thickness of the slip which yields the sound of the middle C is about nine hundredths of an inch; and the thickness of the slip which yields the sound of the first treble C is about eighteen hundredths. Those two Cs are the two extremes. Each slip yields a sound which is extremely pure. The same brass support, which terminates in three pointed corks, serves for each slip in succession. Each slip is similarly placed on that support, is struck by the same cork hammer, with the same elastic force, and on the corresponding spot, each time. By means of this simple tuning apparatus, which is pitched to my NEW AND IMPROVED TEMPERAMENT, any careful person, with a moderate ear, can tune an instrument perfectly, and better perhaps than the best tuner could do without this admirable assistance, which to persons in the country may be very useful. And, to professional tuners, this permanent and portable tuning instrument will be extremely convenient.

STEREOTYPED AND PRINTED BY A. WILSON, DUKE STREET, LINCOLN'S INN FIELDS.

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